

# SCIENCE

AUGUST 17, 1951

VOLUME 114

NUMBER 2955

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To the scientist, NBS probably appears as the scientists' laboratory, because he is familiar with its work on constants of nature, physical properties of basic materials, fundamental standards of measurement, and methods and instruments of measurement. The engineer is familiar with developmental aspects of its work, calibration services, and such activities as structural engineering. The public sees NBS as custodian of the national standards of weights and measures. The military see NBS as a successful discoverer and developer of weapons. In World War II it played a key role in the atomic bomb project and developed the only successfully used, completely automatic guided missile, as well as the proximity fuze for nonrotating projectiles.

During these fifty years the work has grown, in keeping with the growth of science and technology. Three factors, above all others, account for the growth.

First, progress in science and technology has depended on greater precision in fundamental standards, measurement, and the values of physical constants. Advances of this kind are suggested by NBS work on Mercury 198, which affords an atomic standard of length, the "atomic" clock for time measurement, and the measurement of the absolute moment of the proton.

Second, as new fields have opened up, NBS has had to assume new responsibilities. The large expansion of the useful radio frequency spectrum during the past fifteen years required the establishment of a division devoted to problems of radio propagation, measurement standards and methods, and prediction services.

Work proceeds in atomic and nuclear physics, mathematics, electronics, high polymers, and cryogenics.

Third, NBS has undertaken major programs sponsored by the Department of Defense and the Atomic Energy Commission, and these responsibilities have been increased by the national emergency.

The nature of the program is indicated by the names of the 15 scientific and technical divisions: electricity, optics and metrology, heat and power, atomic and radiation physics, chemistry, mechanics, organic and fibrous materials, metallurgy, mineral products, building technology, applied mathematics, electronics, ordnance development, radio propagation, and missile development. A sixteenth division—cryogenic engineering—is about to be activated. The staff totals some 4,000 people, of whom approximately 1,800 are professionally trained scientists and engineers. Most of the bureau's laboratories are located in Washington, but 21 field stations are maintained: the Institute of Numerical Analysis in Los Angeles, 12 radio propagation field stations, six test and inspection stations, and two proving grounds.

Major facilities have recently been acquired at Corona, California, and Boulder, Colorado. At Corona 100 acres of land and buildings having 300,000 square feet of space were transferred to NBS by the Navy, to accommodate the missile development division, as well as other activities intended to make the laboratory a well-integrated research center in electronics and related fields. The Boulder Laboratories will house the cryogenic engineering division and a radio laboratory.

An anniversary of an institution is an appropriate time to focus attention on its people. Whatever the reputation and achievements of the bureau, they belong to the members of the staff, who have contributed much to science and to the nation. Their record is to be found in the thousands of research papers and reports of the past fifty years. It is that record which ultimately describes the institution, reveals its character, and establishes its value.

E. U. CONDON

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SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at the Business Press, 10 McGovern Ave., Lancaster, Pa. Entered as second-class matter at the Post Office at Lancaster, Pa., January 13, 1948, under the Act of March 3, 1879. Acceptance for mailing at the special rate postage provided for in the Act of February 28, 1925, embodied in Paragraph (d-2) Section 34.40 P. L. & R. of 1948.

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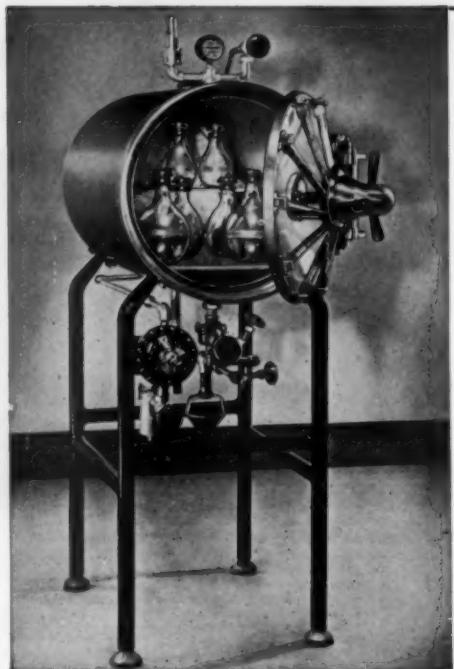


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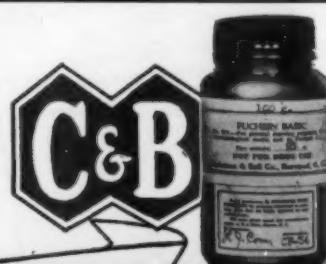
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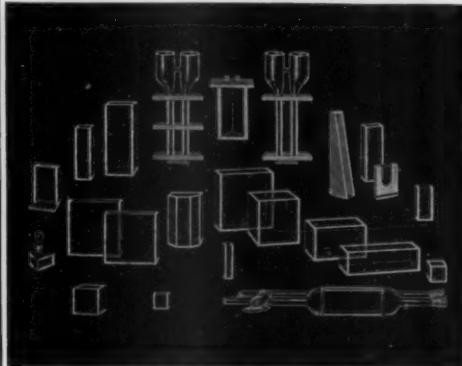
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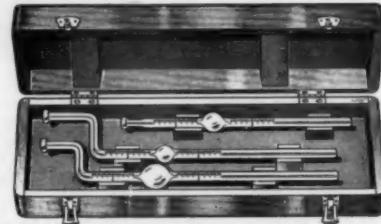
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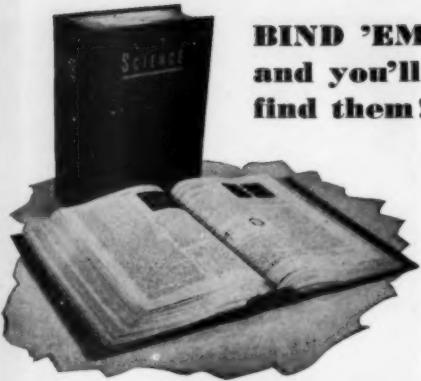
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# Information, Measurement, and Quantum Mechanics<sup>1</sup>

Jerome Rothstein

*Solid State Devices Section, Thermionics Branch, Evans Signal Laboratory,  
Belmar, New Jersey*

RECENT DEVELOPMENTS IN COMMUNICATION THEORY use a function called the entropy, which gives a measure of the quantity of information carried by a message. This name was chosen because of the similarity in mathematical form between informational entropy and the entropy of statistical mechanics. Increasing attention is being devoted to the connection between information and physical entropy (1-9), Maxwell's demon providing a typical opportunity for the concepts to interact.

It is the purpose of this paper to present a short history of the concepts of entropy and information, to discuss information in physics and the connection between physical and informational entropies, and to demonstrate the logical identity of the problem of measurement and the problem of communication. Various implications for statistical mechanics, thermodynamics, and quantum mechanics, as well as the possible relevance of generalized entropy for biology, will be briefly considered. Paradoxes and questions of interpretation in quantum mechanics, as well as reality, causality, and the completeness of quantum mechanics, will also be briefly examined from an informational viewpoint.

## INFORMATION AND ENTROPY

Boltzmann's discovery of a statistical explanation for entropy will always rank as one of the great achievements in theoretical physics. By its use, he was able to show how classical mechanics, applied to billiard-ball molecules or to more complicated mechanical systems, could explain the laws of thermodynamics. After much controversy (arising from the reversibility of mechanics as opposed to the irreversibility of thermodynamics), during which the logical basis of the theory was recast, the main results were firmly based on the abstract theory of measurable sets. The function Boltzmann introduced depends on how molecular positions and momenta range over their possible values (for fixed total energy), becoming larger with increasing randomness or spread in these molecular parameters, and decreasing to zero for a perfectly sharp distribution. Entropy often came to be described in later years as a measure of disorder, randomness, or chaos. Boltzmann himself saw later

that statistical entropy could be interpreted as a measure of missing information.

A number of different definitions of entropy have been given, the differences residing chiefly in the employment of different approximations or in choosing a classical or quantal approach. Boltzmann's classical and Planck's quantal definitions, for example, are, respectively,

$$S = -k \int f \log f d\tau,$$

and       $S = k \log P.$

Here  $k$  is Boltzmann's constant,  $f$  the molecular distribution function over coordinates and momenta,  $d\tau$  an element of phase space, and  $P$  the number of independent wave functions consistent with the known energy of the system and other general information, like requirements of symmetry or accessibility.

Even before maturation of the entropy concept, Maxwell pointed out that a little demon who could "see" individual molecules would be able to let fast ones through a trap door and keep slow ones out. A specimen of gas at uniform temperature could thereby be divided into low and high temperature portions, separated by a partition. A heat engine working between them would then constitute a *perpetuum mobile* of the second kind. Szilard (1), in considering this problem, showed that the second law of thermodynamics could be saved only if the demon paid for the information on which he acted with entropy increase elsewhere. If, like physicists, the demon gets his information by means of measuring apparatus, then the price is paid in full. He was led to ascribe a thermodynamical equivalent to an item of information. If one knew in which of two equal volumes a molecule was to be found, he showed that the entropy could be reduced by  $k \log 2$ .

Hartley (2), considering the problem of transmitting information by telegraph, concluded that an appropriate measure of the information in a message is the logarithm of the number of equivalent messages that might have been sent. For example, if a message consists of a sequence of  $n$  choices from  $k$  symbols, then the number of equivalent messages is  $k^n$ , and transmission of any one conveys an amount of information  $n \log k$ . In the hands of Wiener (3, 4), Shannon (5), and others, Hartley's heuristic beginnings become a general, rigorous, elegant, and powerful theory related to statistical mechanics and promising to revolutionize communication theory. The ensemble of possible messages is characterized by a quantity

<sup>1</sup> Presented in shorter form before the American Physical Society Feb. 1, 1951, and before a physics seminar at Purdue University Feb. 21, 1951.

completely analogous to entropy and called by that name, which measures the information conveyed by selection of one of the messages. In general, if a subensemble is selected from a given ensemble, an amount of information equal to the difference of the entropies of the two ensembles is produced. A communication system is a means for transmitting information from a source to a destination and must be capable of transmitting any member of the ensemble from which the message is selected. Noise introduces uncertainty at the destination regarding the message actually sent. The difference between the *a priori* entropy of the ensemble of messages that might have been selected and the *a posteriori* entropy of the ensemble of messages that might have given rise to the received signal is reduced by noise so that less information is conveyed by the message.

It is clear that Hartley's definition of quantity of information agrees with Planck's definition of entropy if one correlates equivalent messages with independent wave functions. Wiener and Shannon generalize Hartley's definition to expressions of the same form as Boltzmann's definition (with the constant  $k$  suppressed) and call it entropy. It may seem confusing that a term connoting lack of information in physics is used as a measure of amount of information in communication, but the situation is easily clarified. If the message to be transmitted is known in advance to the recipient, no information is conveyed to him by it. There is no initial uncertainty or doubt to be resolved; the ensemble of *a priori* possibilities shrinks to a single case and hence has zero entropy. The greater the initial uncertainty, the greater the amount of information conveyed when a definite choice is made. In the physical case the message is not sent, so to speak, so that physical entropy measures how much physical information is missing. Planck's entropy measures how uncertain we are about what the actual wave function of the system is. Were we to determine it exactly, the system would have zero entropy (pure case), and our knowledge of the system would be maximal. The more information we lose, the greater the entropy, with statistical equilibrium corresponding to minimal information consistent with known energy and physical make-up of the system. We can thus equate physical information and negative entropy (or negentropy, a term proposed by Brillouin [9]). Szilard's result can be considered as giving thermodynamical support to the foregoing.

#### MEASUREMENT AND COMMUNICATION

Let us now try to be more precise about what is meant by information in physics. Observation (measurement, experiment) is the only admissible means for obtaining valid information about the world. Measurement is a more quantitative variety of observation; e.g., we observe that a book is near the right side of a table, but we measure its position and orientation relative to two adjacent table edges. When we make a measurement, we use some kind of procedure and apparatus providing an ensemble of possi-

ble results. For measurement of length, for example, this ensemble of *a priori* possible results might consist of: (a) too small to measure, (b) an integer multiple of a smallest perceptible interval, (c) too large to measure. It is usually assumed that cases (a) and (c) have been excluded by selection of instruments having a suitable range (on the basis of preliminary observation or prior knowledge). One can define an entropy for this *a priori* ensemble, expressing how uncertain we are initially about what the outcome of the measurement will be. The measurement is made, but because of experimental errors there is a whole ensemble of values, each of which could have given rise to the one observed. An entropy can also be defined for this *a posteriori* ensemble, expressing how much uncertainty is still left unresolved after the measurement. We can define the quantity of physical information obtained from the measurement as the difference between initial (*a priori*) and final (*a posteriori*) entropies. We can speak of position entropy, angular entropy, etc., and note that we now have a quantitative measure of the information yield of an experiment. A given measuring procedure provides a set of alternatives. Interaction between the object of interest and the measuring apparatus results in selection of a subset thereof. When the results of this process of selection become known to the observer, the measurement has been completed.

It is now easy to see that there is an analogy between communication and measurement which actually amounts to an identity in logical structure. Fig. 1

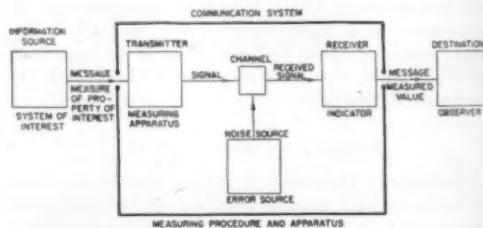


FIG. 1.

shows this less abstractly. The blocks and upper captions follow Shannon's characterization of a communication system; the lower captions give analogous terms for a measuring apparatus. The system of interest corresponds to the information source, the observer to the destination for which the message is intended. The message corresponds to a measure of the property of interest, which is often encoded by the transmitter or measuring apparatus into a signal consisting of information-bearing variations of some physical quantity, often quite distinct from the one of direct interest. The signal, corrupted by noise or errors, is decoded by the receiver or indicator and presented as a message or measured value at the output of the system. Calibration in measurement is, in part, the analog of distortion correction in communication. In practice a communication or measuring

system often consists of a number of subsystems in series, intermediate ones serving as destinations for their predecessors and as sources for their successors. The sensory and nervous apparatus of the observer can be considered the ultimate system, which, together with instruments, operations, and apparatus, constitutes the means whereby the mind of the scientist communicates with, or acquires information about, the universe.

#### PHYSICAL CONSEQUENCES OF THE INFORMATION VIEWPOINT

Some implications of the informational viewpoint must be considered. First of all, the entropy of information theory is, except for a constant depending on choice of units, a straightforward generalization of the entropy concept of statistical mechanics. Information theory is abstract mathematics dealing with measurable sets, with choices from alternatives of an unspecified nature. Statistical mechanics deals with sets of alternatives provided by physics, be they wave functions, as Planck's quantal definition, or the complexities in phase space of classical quantum statistics. Distinguishing between identical particles (which leads to Gibbs' paradox and nonadditivity of entropy) is equivalent to claiming information that is not at hand, for there is no measurement yielding it. When this nonexistent information is discarded, the paradox vanishes. Symmetry numbers, accessibility conditions, and parity are additional items of (positive or negative) information entering into quantal entropy calculations.

Second, we can formulate the statistical expression of the second law of thermodynamics rather simply in terms of information: Our information about an isolated system can never increase (only by measurement can new information be obtained). Reversible processes conserve, irreversible ones lose information.

Third, all physical laws become relationships between types of information, or information functions collected or constructed according to various procedures. The difference between classical or quantum mechanics, on one hand, and classical or quantum statistics, on the other, is that the former is concerned with theoretically maximal information, the latter with less than the maximal. From the present viewpoint, therefore, classical and quantum mechanics are limiting cases of the corresponding statistics, rather than separate disciplines. The opposite limiting cases—namely, minimum information or maximum entropy—relate to the equilibrium distributions treated in texts on statistical mechanics. The vast, almost virgin field of nonequilibrium physics lies between these two extremes.

It is tempting to speculate that living matter is distinguished, at least in part, by having a large amount of information coded in its structure. This information would be in the form of "instructions" (constraints) restricting the manifold of possibilities for its physicochemical behavior. Perhaps instructions for developing an organism are "programmed" in the

genes, just as the operation of a giant calculating machine, consisting of millions of parallel or consecutive operations, is programmed in a control unit. Schrödinger, in a fascinating little book, *What Is Life?* views living matter as characterized by its "disentropic" behavior, as maintaining its organization by feeding on "negative entropy," the thermodynamic price being a compensating increase in entropy of its waste products. Gene stability is viewed as a quantum effect, like the stability of atoms. In view of previous discussion, the reader should have no trouble fitting this into the informational picture above.

Returning to more prosaic things, we note, fourth, that progress either in theory of measurement or in theory of communication will help the other. Their logical equivalence permits immediate translation of results in one field to the other. Theory of errors and of noise, of resolving power and minimum detectable signal, of best channel utilization in communication and optimal experimental design are three examples of pairs where mutual cross-fertilization can be confidently expected.

Fifth, absolutely exact values of measured quantities are unattainable in general. For example, an infinite amount of information is required to specify a quantity capable of assuming a continuum of values. Only an ensemble of possibly "true" or "real" values is determined by measurement. In classical mechanics, where the state of a system is specified by giving simultaneous positions and momenta of all particles in the system, two assumptions are made at this point—namely, that the entropy of individual measurements can be made to approach zero, and furthermore that this can be done simultaneously for all quantities needed to determine the state of the system. In other words, the ensembles can be made arbitrarily sharp in principle, and these sharp values can be taken as "true" values. In current quantum mechanics the first assumption is retained, but the second is dropped. The ensembles of position and momenta values cannot be made sharp simultaneously by any measuring procedure. We are left with irreducible ensembles of possible "true" values of momentum, consistent with the position information on hand from previous measurements. It thus seems natural, if not unavoidable, to conclude that quantum mechanics describes the ensemble of systems consistent with the information specifying a state rather than a single system. The wave function is a kind of generating function for all the information deducible from operational specification of the mode of preparation of the system, and from it the probabilities of obtaining possible values of measurable quantities can be calculated. In communication terminology, the stochastic nature of the message source—i.e., the ensemble of possible messages and their probabilities—is specified, but not the individual message. The entropy of a given state for messages in *x*-language, *p*-language, or any other language, can be calculated in accordance with the usual rules. It vanishes in the language of a given observable if, and only if, the

state is an eigenstate of that observable. For an eigenstate of an operator commuting with the Hamiltonian, all entropies are constant in time, analogous to equilibrium distributions in statistical mechanics. This results from the fact that change with time is expressed by a unitary transformation, leaving inner products in Hilbert space invariant. The corresponding classical case is one with maximal information where the entropy is zero and remains so. For a wavepacket representing the result of a position measurement, on the other hand, the distribution smears out more and more as time goes on, and its entropy of position increases. We conjecture, but have not proved, that this is a special case of a new kind of quantal  $H$ -theorem.

Sixth, the informational interpretation seems to resolve some well-known paradoxes (10). For example, if a system is in an eigenstate of some observable, and a measurement is made on an incompatible observable, the wave function changes instantaneously from the original eigenfunction to one of the second observable. Yet Schroedinger's equation demands that the wave function change continuously with time. In fact, the system of interest and the measuring equipment can be considered a single system that is unperturbed and thus varying continuously. This causal anomaly and action-at-a-distance paradox vanishes in the information picture. Continuous variation occurs so long as no new information is obtained incompatible with the old. New information results from measurement and requires a new representative ensemble. The system of interest could "really" change continuously even though our information about it did not. It does no harm to believe, as Einstein does, in a "real" state of an individual system, so long as one remembers that quantum mechanics does not permit an operational definition thereof. The Einstein-Podolsky-Rosen paradox (11), together with Schroedinger's (12) sharpening of it, seems to be similarly resolved. Here two systems interact for a short time and are then completely separated. Measurement of one system determines the state of the other. But the kind of measurement is under the control of the experimenter, who can, for example, choose either one of a pair of complementary observables. He obtains one of a pair of incompatible wave functions under conditions where an objective or "real" state of the system cannot be affected. If the wave function describes an individual system, one must renounce all belief in its objective or "real" state. If the wave function only bears information and describes ensembles consistent therewith, there is no paradox, for an individual system can be compatible with both of two inequivalent ensembles, as long as they have a nonempty intersection. The kind of information one gets simply varies with the kind of measurement one chooses to make.

#### REALITY, CAUSALITY, AND THE COMPLETENESS OF QUANTUM MECHANICS

We close with some general observations.

First, it is possible to believe in a "real" objective

state of a quantum-mechanical system without contradiction. As Bohr and Heisenberg have shown, states of simultaneous definite position and definite momentum in quantum mechanics are incompatible because they refer to simultaneous results of two mutually exclusive procedures. But, if a variable is not measured, its corresponding operation has not been performed, and so unmeasured variables need not correspond to operators. Thus there need be no conflict with the quantum conditions. If one denies simultaneous reality to position and momentum then EPR forces the conclusion that one or the other assumes reality only when measured. In accepting this viewpoint, should one not assume, for consistency, that electrons in an atom have no reality, because any attempt to locate one by a photon will ionize the atom? The electron then becomes real (i.e., is "manufactured") only as a result of an attempt to measure its position. Similarly, one should also relinquish the continuum of space and time, for one can measure only a countable infinity of locations or instants, and even this is an idealization, whereas a continuum is uncountable. If one admits as simultaneously real all positions or times that *might* be measured, then for consistency simultaneous reality of position and momentum must be admitted, for either one might be measured.

Second, it is possible to believe in a strictly causal universe without contradiction. Quantum indeterminacy can be interpreted as reflecting the impossibility of getting enough information (by measurement) to permit prediction of unique values of all observables. A demon who can get physical information in other ways than by making measurements might then see a causal universe. Von Neumann's proof of the impossibility of making quantum mechanics causal by the introduction of hidden parameters assumes that these parameters are values that internal variables can take on, the variables themselves satisfying quantum conditions. Causality and reality (i.e., objectivity) have thus been rejected on similar grounds. Arguments for their rejection need not be considered conclusive for an individual system if quantum mechanics be viewed as a Gibbsian statistical mechanics of ensembles.

The third point is closely connected with this—namely, that quantum mechanics is both incomplete in Einstein's sense and complete in Bohr's sense (13). The former demands a place in the theory for the "real" or objective state of an individual system; the latter demands only that the theory correctly describe what will result from a specified operational procedure—i.e., an ensemble according to the present viewpoint. We believe there is no reason to exclude the possibility that a theory may exist which is complete in Einstein's sense and which would yield quantum mechanics in the form of logical inferences. In the communication analogy, Bohr's operational viewpoint corresponds to demanding that the ensemble of possible messages be correctly described by theory when the procedure determining the message source is given

with maximum detail. This corresponds to the attitude of the telephone engineer who is concerned with transmitting the human voice but who is indifferent to the meaning of the messages. Einstein's attitude implies that the messages may have meaning, the particular meaning to be conveyed determining what message is selected. Just as no amount of telephonic circuitry will engender semantics, so does "reality" seem beyond

experiment as we know it. It seems arbitrary, however, to conclude that the problem of reality is meaningless or forever irrelevant to science. It is conceivable, for example, that a long sequence of alternating measurements on two noncommuting variables carried out on a single system might suggest new kinds of regularity. These would, of course, have to yield the expectation values of quantum mechanics.

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## Technical Papers

### An Approach to the Microscopy of Molecules

Marsden S. Blois, Jr.<sup>1</sup>

*Department of Physics,  
Stanford University, Stanford, California*

During the course of taking a number of electron micrographs of very thin evaporated metallic deposits, it has been noticed that under certain conditions the discontinuous distributions of particles have been subject to strong orienting effects. The general behavior of these deposits and their appearance under the electron microscope have received considerable attention during the past several years, and excellent photographs by Levinstein (1), Sennett and Scott (2), and others have confirmed the existence of isolated agglomerations of metal which appear to conform to the prediction of a theory of Lennard-Jones (3).

Fig. 1, which is an electron micrograph of a silver deposit of average thickness of the order of 10 Å on collodion, illustrates this orienting effect and shows an elementary structural unit that is circular in form, with a corresponding tendency for these units to link up and form a linear headlike pattern. The explanation given for the existence of discrete particles is that the metallic atoms or molecules upon arriving at the substrate surface give up enough energy upon contact so as not to re-evaporate, but retain an energy sufficient to resist being bound in place. Since in general the binding of a metal atom for another metal atom is large compared with the binding to the organic

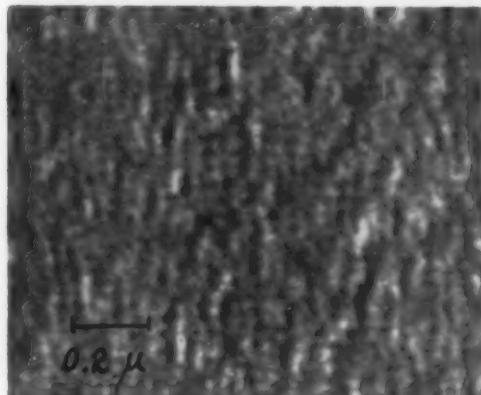


FIG. 1. An evaporated deposit of silver (av thickness, 10 Å) on collodion. Note headlike structure of the dark metallic particles.

material composing the substrate, the metallic atoms then tend to drift about on the surface until (a) they coalesce with a metallic particle or (b) lose enough energy before collision with a metallic particle so that they become bound by the substrate.

Although the foregoing explains the appearance of the small circular units, the linear orienting effect remains to be accounted for. One possibility considered was distortion of the microscope. However, there has been no dependence upon position in the field or any geometrical symmetries of the patterns. As Figs. 2-5 show, there is no systematic optical defect to be found. Another possible cause that was quickly disposed of is the motion of the object during the exposure interval. This may give a somewhat similar result, but

<sup>1</sup> The author takes this opportunity of expressing his gratitude to J. F. Rinchart, of the University of California Medical School, for the use of the electron microscope and to E. I. du Pont de Nemours and Company for preparation of the nitrocellulose samples.

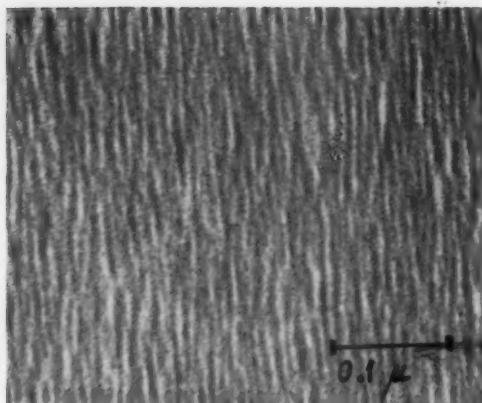


FIG. 2. Mapping of nitrocellulose molecules by 10 Å of gold.  
Molecular length, .09 μ.

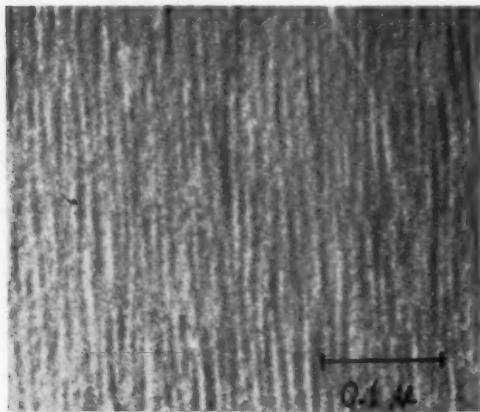


FIG. 3. Mapping of nitrocellulose molecules by 10 Å of gold.  
Molecular length, .48 μ.

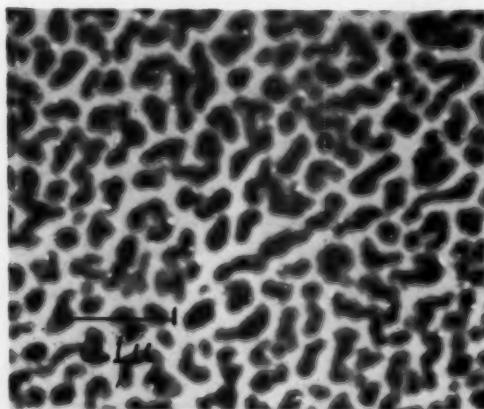


FIG. 4. Deposit of gold on collodion (unstressed).

pictures showing forked patterns, for example, were obtained that would have been smeared out by motion of the object. In addition, larger particles that had been intentionally placed on the specimens showed up as undistorted images.

A remaining explanation is that the effect is due to actual structure of the substrate material, in particular to linear molecules themselves. Since the collodion that had been used consists of a distribution of polymer lengths, some samples were obtained of nitrocellulose that had been separated by fractionation methods into groups with fairly uniform molecular weights and hence polymer lengths. The nitrocellulose was dissolved in amyl acetate, and thin films were formed on a water surface. Both gold and silver in small amounts (av thicknesses of about 10 Å-20 Å)

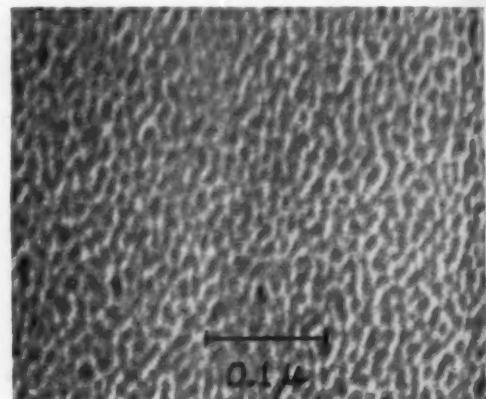


FIG. 5. Nitrocellulose molecules mapped out by metallic deposit.

were deposited by evaporation, and it was apparent that the lengths of the linear metallic deposits depended upon the polymer length of the substrate. Figs. 2 and 3 are of gold deposits on nitrocellulose, the former having an average polymer length of 950 Å and the latter 5020 Å. The branched, open structure to be expected in a semipermeable membrane such as collodion can be clearly seen. For one particular sample the measured polymer lengths from the micrograph agreed to within about 50% with the result determined by viscosity measurements. For the remaining samples (having longer molecules) the mapping by the metal showed increasing length, but in no case were the mapped lengths as long as the actual molecular lengths. It would appear that using the foregoing techniques molecular lengths in the range 100 Å-1000 Å are most suitably investigated. The lower limit is set by a combination of microscopic resolving power and the minimum-sized metallic particles that can be produced by conventional evaporation methods, and the upper limit by the competition between the inclination of the metallic atoms to form stable metallic agglomerations, and the tendency to form what may be considered as the metastable map-

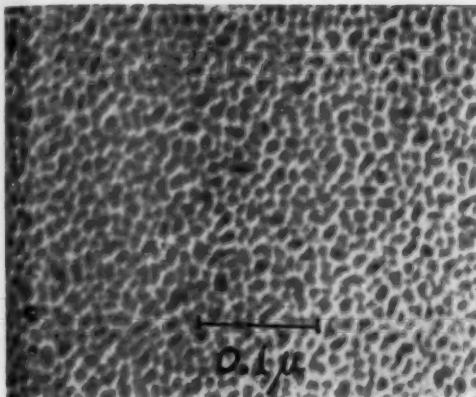


FIG. 6. Same region of the nitrocellulose film as in Fig. 5, after 5 min in the electron beam of the microscope.

ping configuration, the latter becoming less the higher the degree of asymmetry of the substrate.

During the preparation of the substrate films the molecules are generally in a tangled state, and in order to draw them out into a linear structure it is necessary to produce local stresses. This occurs naturally during the drying of the films, and it is only necessary to hunt for regions that have been strained in order to find the desired linear effect. Fig. 4 shows what appears to be a mapping of the molecules in an unstrained state with the polymers lying in a tangled or skein-like configuration.

Figs. 5 and 6 are of the identical portion of a gold deposit on a nitrocellulose film, the former being exposed as soon as a focus was obtained, and the latter exposure made 5 min later, the object remaining in place in the electron microscope and subjected to the 300- $\mu$ a electron beam between pictures. It will be noted that, whereas Fig. 5 shows most of the particles connected with others, Fig. 6 shows that the metal formerly lying in the connecting filaments has, under the excitation of the electron bombardment, migrated to the larger metallic groups, with the result that the particles have drawn themselves into more stable configurations.

This phenomenon clearly supports the mechanism discussed above as to the formation of these structures. The method is not "shadowing" in the sense that this term is employed in the preparation of transparent objects for electron microscopy; because of the migration of the metal atoms after they arrive on the substrate the structure seen in the present manner is another order of magnitude smaller.

Although an obvious step toward improvement of the resolution of this process would seem to lie in applying Levinstein's finding that metals having higher melting points will form smaller particles, it happens that some metals, palladium and nickel in particular, form continuous films in such thin deposits that the mapping is not striking. Thus for the configuration of the metallic deposit to be responsive to

the details of the substrate, it is necessary that the metal used be one which shows a distinct tendency toward migration.

It might be mentioned that the present procedure is a close analog to the conventional staining of specimens for observation under the light microscope; in both instances the contrast between object and background is increased by the selective absorption or attraction of some material having a high stopping power for the radiation being used.

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## Peptide Structure and Denaturation of Proteins

A. R. Goldfarb

*Department of Biochemistry,  
Chicago Medical School, Chicago, Illinois*

The denaturation of proteins has been described in terms of altered solubility, appearance of functional groups, and change of shape of the molecule (1). It has been reported from this laboratory that absorption spectra data at 205 m $\mu$  can be correlated with the peptide structure of proteins. It was hypothesized that any alteration of configuration of the protein might have an influence on the absorption due to the peptide bond by changing the electron configuration of this bond. In a series of preliminary experiments very dilute solutions of bovine plasma albumin were heated to 100° C, and immediately chilled at given intervals. The optical densities of these solutions were determined. At the concentrations used and under the conditions of the experiments, no turbidity was formed and the solutions were optically clear. The optical density rose markedly to values which depended on the concentration of protein (9–40 mg/l) and on the time of heating. After the initial rise the density showed a gradual fall with continued heating. This type of curve is qualitatively confirmed, but the quantitative confirmation is not very good. The maximum rate of rise in density occurs in a matter of seconds, and it is conceivable that the quenching of the initial rise has not been reproducible under the conditions of these preliminary experiments.

During this early work it was also observed that if a concentrated solution of the protein (about 1%) was rapidly heated to a boil and immediately cooled, a precipitate formed during the heating. This precipitate on dilution dissolved to an optically clear solution. The precipitate was more soluble in water at pH 3.5 and 7.5. If, however, the suspension was heated for 5 min or longer, the precipitate was completely insoluble both on dilution and by alteration of pH and was soluble only at pH about 10.

It would appear from this preliminary data that

denaturation may involve several steps that are either competitive or successive. In general the steps involved would be (a) an alteration of the steric relation between the constituent amino acids so as to alter the peptide bond configuration, (b) a reaction in which an equilibrium spatial configuration is reached that is consistent with the temperature and time of heating, (c) an interaction of proteins (precipitation) in more concentrated solutions, which is competitive with reaction (a). This step is indicated by the finding that the redissolved precipitates show very nearly the same density as the undenatured proteins. In this case it is presumed that the number of peptide bonds altered at the time of precipitation of the protein is sufficiently small so that no change in density is detectable, (d) a continued change of the precipitated protein leading to greater insolubility. It is not possible to discuss this last step in terms of the absorption characteristics at this time, since solutions of the precipitate at high pH cannot be studied at present.

This study is being continued further, and the effect of other types of denaturing agents will be investigated, as well as the kinetics of the change.

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### A Method for Embedding Undecalcified Bone for Histologic Sectioning, and its Application to Radioautography

James S. Arnold<sup>1</sup>

*Division of Biological and Medical Research,  
Argonne National Laboratory, Chicago, Illinois*

In developing a high resolution radioautographic method for the study of the distribution of radioisotopes in bone it is highly desirable to obtain thin sections of bone. Up to the present, the method of choice has consisted of embedding in celloidin and covering the cut surface of the block with an additional thin coat of celloidin prior to sectioning (1-3).

Celloidin embedding has proved satisfactory for comparatively soft bones, such as those of young rats, mice, and rachitic animals, and the bone of osteochondral junctures. However, celloidin<sup>2</sup> lacks the adhesive and cohesive properties necessary to hold individual particles of brittle bone firmly in the section. Furthermore, this embedding medium insufficiently impregnates the interior of dense cortical bone. Thus, when harder material is embedded in celloidin, crumbling, breaking, and distortion occur, making the sections unsuitable for autographic or histologic use.

To improve the adhesive and cohesive properties

<sup>1</sup> The author wishes to acknowledge the assistance of Atlee S. Tracy, who prepared the photomicrograph.

<sup>2</sup> Celloidin is nitrocellulose dissolved in 50% ether, 50% alcohol. In use, it is evaporated to the proper hardness and stored in 70% alcohol. Under these circumstances alcohol and water act as plasticizing materials, separating the molecules of nitrocellulose and altering its hardness.

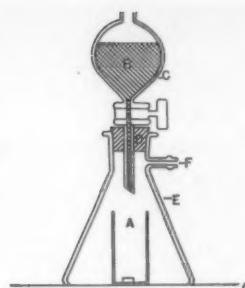


FIG. 1. Vacuum embedding apparatus. A, Vial containing tissue; B, solution of plastic; C, separatory funnel; D, rubber stopper; E, suction flask; F, outlet to water aspirator; G, plate glass and ground upper surface.

of the embedding medium, the effect of the addition of various plasticizers—Herculin D, castor oil, and diethyl phthalate—was tested. Diethyl phthalate evidenced the best properties for this purpose. Penetration of the embedding medium was increased by (1) using acetone as the solvent (rather than 50% ether-alcohol), and (2) embedding under partial vacuum, followed by higher temperature (60° C) and pressure (3 atm).

After the problem of obtaining sufficiently thin sections of bone is solved, preparation of radioautographs is comparatively simple. In this work, a modification of the methods independently developed by Endicott and Yagoda (4) and T. C. Evans (5) was used. By our method, the sections were mounted on slides that had been coated with a nuclear track emulsion. All studies during the developmental period were made on bones that contained varying amounts of plutonium.<sup>3</sup>

Tissues may be fixed in any desired fixative for routine histologic purposes. When radioautographs are to be made, however, the possibility of the fixative leaching out or redistributing the contained isotopes or producing chemical blackening of nuclear track emulsion on contact must be taken into account. Absolute acetone was found to be a satisfactory fixative, since plutonium is not leached from the tissues. Following fixation, tissues not fixed in acetone are progressed into absolute acetone which has been dried with sodium sulfate. This serves the dual purpose of dehydration and preparing the tissues for embedding in acetone solution of plastic. The plastic itself is prepared as follows: 11 parts air-dried 1/2-sec nitrocellulose is mixed with 9 parts diethyl or dibutyl phthalate and dissolved in anhydrous acetone so that the final solution contains 50-60% solids by weight. Previously prepared tissue is removed from the absolute acetone and placed in a vacuum embedding chamber. This chamber consists of a separatory funnel in the top of a vacuum flask with the bottom cut out, the flask resting on a lubricated, ground surface of plate glass

<sup>3</sup> Plutonium was used because of its uncomplicated  $\alpha$ -decay and the convenience of working with low-background emulsions suitable for  $\alpha$ -track recording.

(Fig. 1). The chamber is then exhausted by means of an aspirator to a pressure of about 1 cm Hg. The tissue remains at this pressure for about 30 min. The stopcock of the separatory funnel is then opened very slightly to permit slow entrance of the embedding medium. The acetone in the embedding medium volatilizes, cooling the entering material to below its boiling point at the reduced pressure.<sup>4</sup> After the tissue has been completely covered by the concentrated, cooled embedding medium, the stopcock is opened to allow rapid entrance of about 5 volumes embedding medium for each volume of tissue. The pressure is returned to atmospheric, and the vial containing the vacuum-embedded tissue is transferred to a high-pressure embedding apparatus<sup>5</sup> which is constructed to regulate temperature and pressure over a wide range. Here the pressure is raised to 3 atmospheres, and the temperature of the solution is raised to 60°–65° C, where it remains for 24–48 hr, depending on the size and the density of the specimen. To evaporate acetone solvent, the tissue is then removed and placed in a paper dish filled with fresh plastic solution. This dish is so constructed that its walls extend upward about 5 times the height of the desired thickness of dried plastic. The paper walls allow rapid and uniform evaporation of acetone from the embedded block. The dish is set aside in a place where the temperature is below 70° F, until the contents become puttylike in consistency, which usually requires 4–5 days. Too rapid evaporation of the acetone results in bubble formation in the plastic when it is in a fluid condition. The tissues are cut from the puttylike plastic and oriented in the desired method on regular tissue blocks that have been generously covered with the solution of plastic. The block is left at room temperature until it becomes quite hard—about a week. It may then be placed in a 60° C oven overnight for final hardening.

Satisfactory sections 5μ–8μ thick may be serially cut dry for soft tissues, and wet for hard tissues. One per cent aerosol in water is used as a wetting solution. For purely histologic purposes, sections are cut with a heavy sliding microtome and specially hardened knife blades, mounted on albumin-covered slides, and treated as celloidin sections. When radioautographs are to be made, damp sections are placed on a clean glass plate and flattened out by blotting. Later, in the darkroom with appropriate lighting, sections are refloated with 1% aerosol and transferred with a section spatula to the dry nuclear track emulsion covered slide.<sup>6</sup> The moisture adherent to the section serves to moisten the underlying emulsion. The slide carrying the emulsion and mounted tissue is then submerged in absolute acetone for 2–3 min to dehydrate the underlying emulsion and remove the plastic from the mounted section. Acetone

is allowed to evaporate for a minute in air from the slides, and they are then put away for the desired exposure period in a dark box containing chemical desiccant for humidity control. Autographs are subsequently developed for 3 min in Kodak D-19, fixed in x-ray fixer and hardener, and washed in running water for 30 min. Following air-drying, slides are treated with 5% formalin, which prevents liquefaction of the emulsion in subsequent staining procedures.

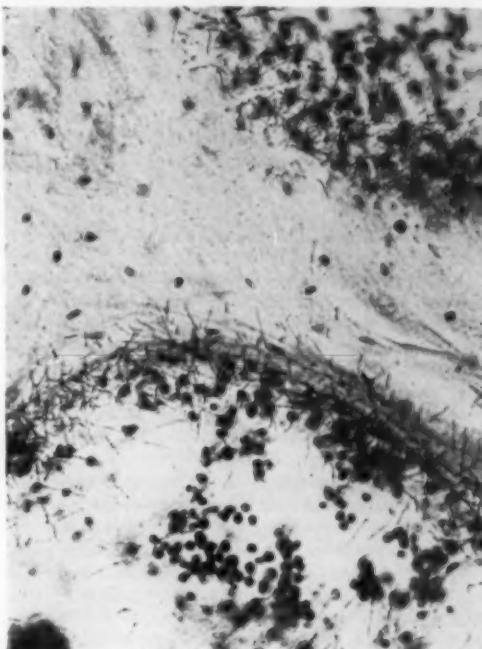


FIG. 2. Low-power photomicrograph showing both tracks and tissue.  $\times 395$ .

Autographs are overstained in Harris hematoxylin, destained to the desired point in 5% ammonium alum, counterstained with 0.5% eosin, dehydrated progressively through alcohols, cleared in xylene, and mounted in clarite. Examination of radioautographs is done under bright-field illumination.

In the course of these studies it was found that successful cutting of undecalcified bone for histologic and radioautographic purposes depended on the completeness of penetration of the embedding medium, regardless of what medium was used. The adhesive and cohesive properties of the embedding medium are likewise important. The cellular distortion produced by acetone fixation and slight shrinkage in embedding was not so great as might be expected. The staining qualities of the tissue so fixed and embedded are quite satisfactory for cellular recognition, though more detailed studies are yet to be completed.

Radioautographs of plutonium-containing long bones of rats and a dog have been made, which re-

<sup>4</sup>If a larger flow is allowed, the volume of vapor would exceed the small capacity of the aspirator, and the partial vacuum would be lost.

<sup>5</sup>The apparatus for temperature and pressure regulation was designed by John Pomeroy, of this laboratory, and will be described in a later publication.

<sup>6</sup>Eastman Kodak NTA and NTB emulsions, 25-μ thick.

vealed very little redistribution of the contained isotope, and a resolution to the area of a single cell was easily obtained. Fig. 2 shows areas of deposition of plutonium in cortical and trabecular bone by the  $\alpha$ -track localization in underlying NTA emulsion.

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## A Simple Method for Extirpating an Experimental Tumor

Paul A. Zahl<sup>1</sup>

The Haskins Laboratories, New York City

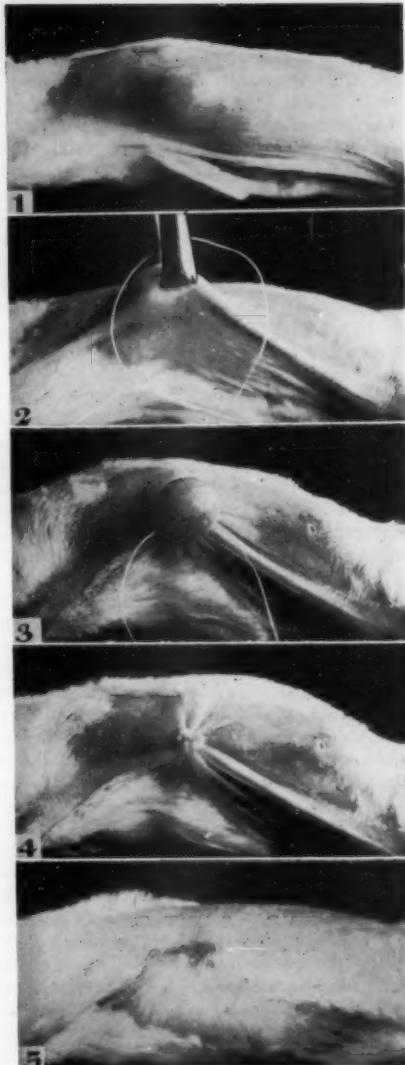
In cancer research on small mammals it is often desirable to observe physiological variables within the body before, during, and after the growth of a non-metastasizing tumor. Thus Greenstein and Andervont (1) studied the catalase content of liver at these stages by implanting a tumor into the tail of a mouse, and achieved complete tumor extirpation at the desired time merely by excising the tail above the position of the growing implant. Lumsden (2), in studies of tumor immunity, employed local vascular occlusion for inducing regression of tumors implanted into the paws of rats. A disadvantage in these methods for general use, however, is that tumors implanted in such remote and confined locations do not grow or infiltrate in a manner comparable to those implanted in the more usual axillary position.

To avoid this disadvantage, the author (3), while studying certain systemic effects of hemorrhage in tumors, used a surgical technique for removing a subcutaneous growth of mouse sarcoma 180 implanted 7 days previously in the axillary position. This operation was not simple; it required careful ligating of involved blood vessels, a relatively large skin incision, and many stitches. The traumatic effects on the mouse of such an operation were considerable, and not all the mice recovered.

Recently a far simpler technique for removing a tumor implanted in the axillary region of the mouse has been used by us. It requires no asepsis, no incision, is extremely rapid, and is followed by uncomplicated recovery of virtually all the mice.

Tumor-bearing mice with sodium sulfide-epilated abdomens are anesthetized with parenterally injected Nembutal. During such anesthesia the abdominal skin becomes relaxed and very elastic (Figs. 1, 2). The tumor is lifted *in situ* by means of a toothed forceps; a loop of heavy cotton thread is thrown around the base of the tumor mass and tied securely (Fig. 3).

<sup>1</sup> Grateful acknowledgment is made of technical assistance rendered by Andrew Nowak.



FIGS. 1-5. Series showing stages in tumor-extirpation procedure.

The tightened loop instantly stops all vascular interchange between the tumor mass and the body. For safety, several additional loops may be applied over the first. The tumor may be excised immediately above the ligature (Fig. 4), or it may be left intact. In the latter case it will wither and slough off within 24 hr, leaving a bunch of skin tissue tightly held in the ligature. Within a few additional days the ligature will drop off, leaving a small and rapidly healing scar area (Fig. 5).

When the operation is performed on mice bearing

7-day-old axillary implants, we have never seen regrowth of tumor tissue at the site of extirpation or in remote sites, although care must be exercised in making the original implant so that no tumor tissue fragments are deposited along the route of trocar entry. Implants of mouse sarcoma 180 older than 7 days become progressively more difficult to remove by this or any other known method, for such growths have usually undergone an irretrievable infiltration into the body wall.

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### Tubal Malignancy—A Method for Collecting Specimens for Cytologic Study

K. Sheldon MacLean

135 East 65th Street, New York

Exfoliative cytology of the female genital tract, since Papanicolaou's monumental work, has become one of the most popular and probably the most important diagnostic procedure for the early detection of cancer. As the diagnostic criteria for the malignant cell become better defined, the percentage of positive diagnoses increases, missed diagnoses become rarer, and false positive diagnoses are almost completely eliminated. The ready accessibility of the cervical canal through which exfoliative cells from the uterine cavity pass (and in some cases from the appendages) renders cytologic investigation a relatively simple procedure.

Unfortunately, however, in cases of tubal malignancy, fewer cells are expected to reach the cervical canal, and consequently their detection becomes difficult and impractical, unless a way is found to collect and concentrate the material over a certain period of time, without added difficulties and without discomfort to the patient. This has been done as follows:

After cleansing the vaginal tract, a plastic cervical cap<sup>1</sup> of proper size is fitted over the cervix. The cap is removed 24 hr later and slides are prepared from the collected material. If the volume of secretion is excessive, the material may be concentrated by centrifuging or by permitting it to settle. Longer periods were tried—e.g., 48, 60, and 72 hr—and after such intervals a larger amount of secretion was collected, as anticipated. Because of autolysis, however, the stain characteristics and clarity of the detailed cellular structure were impaired, making the slides unsuitable for proper interpretation. In some cases the patient complained of physical discomfort and offensive odors if the cap was left longer than 24 hr. It is therefore recommended that the cap be removed in 24 hr, and slides prepared and processed immediately.

<sup>1</sup> Manufactured by the Ortho Pharmaceutical Corporation for use as a contraceptive.

The use of the cap has made possible a positive diagnosis of tubal carcinoma in a clinically unsuspected case in which there was no palpable mass. The diagnosis was subsequently confirmed by operation.<sup>2</sup> The procedure is now in routine use in the writer's practice. Results will be reported later.

<sup>2</sup> The case will be reported in detail later.

### Action of Genes Affecting Secondary Sex Ratio in Man

Marianne E. Bernstein<sup>1</sup>

Istituto di Statistiche, Rome, Italy

C. Gini in Italy and, later, E. Slater in England, have shown conclusively that the tendency in a family to produce offspring of one sex only or primarily one sex, is hereditary. On a large set of American families this author has shown also that there is a decided excess of sibships of only sons or only daughters. Since all these findings point so strongly toward genetic control of the sex ratio, a study was made as to how these genes act. Statistical and experimental investigation led us to advance a theory that the "sex ratio genes" act through the endocrine system, especially the sex hormones. Fathers suffering from endocrine disturbances such as gout, Graves' disease, etc., have more than the average number of female offspring. Bald men were found to have 40% more male offspring than men with full hair or with receding hairline that had not developed into full baldness. Male sex hormones play a role in the development of baldness.

Has the degree of maleness of the father an effect on the sex ratio of the children? We believe that men engaged in aggressive, extrovert occupations, in which few or no women have become outstanding, are more masculine than men engaged in introvert, retiring occupations. In families where the fathers are members of the armed forces, business executives, politicians, lawyers, farmers, abstract scientists like astronomers, mathematicians, etc., the sex ratio of 5,400 children was found to be 120 boys for every 100 girls. However, in families where the fathers were in professions in which many famous women were engaged—i.e., actors, social workers, child educators, fiction writers, and all kinds of artists—the sex ratio for 1,800 children was found to be 85 boys for every 100 girls born. An intermediate group was formed by the families in which the father was engaged in a religious profession, was a research worker, or an applied scientist such as a chemist, biologist, etc.

The author believes that the genes controlling the sex ratio in mammals are identical with, or act through, the genes controlling the male-female sex hormone balance. The X-bearing sperms, because of their 2 chromosomal balance (1A:1S), form a foreign entity in the male reproductive organs, and are destroyed in smaller or larger number inside the male, depending

<sup>1</sup> Fulbright fellow.

on the degree of maleness. On the other hand, male fetuses form an alien factor in the maternal organism, and are thus more easily absorbed than female fetuses. This theory is in agreement with the one advanced by Hoelzel at the University of Chicago that in well-nourished male rats more X-chromosome-bearing sperms than Y-chromosome-bearing sperms are reabsorbed, whereas in well-nourished female rats more male than female fetuses are absorbed.

## A Method for the Rapid Preparation of Histological Sections

John A. Tornaben and Edwin J. de Beer

The Wellcome Research Laboratories,  
Tuckahoe, New York

The preparation of tissue specimens for paraffin embedding is a tedious and time-consuming process. The method described here considerably shortens the time required and reduces the number of operations. Particular economies in this respect have been achieved in the dehydrating step, which has been reduced to a single, simple operation.

Thin pieces of fresh tissue about 4 mm thick, are placed in a modified Bouin's fluid consisting of: 80% ethyl alcohol, 150 ml; 40% formalin, 60 ml; glacial acetic acid, 15 ml; and picric acid crystals, 1 g. A minimum of 35–45 min immersion is required to fix the tissues. No harm is done by permitting them to remain in the fixative overnight. Washing in water is not necessary. Zenker's fluid, Helly's fluid, etc., also may be used, provided that the proper prescribed procedure, including washing, is followed for each fixative.

After fixing in the modified Bouin's fluid, the tissues are cut into slices 1–2 mm thick. This can be done with a razor blade or sharp-edged knife.

Dehydration is rapidly accomplished by placing 4–8 slices of the fixed tissue in an Alliin filter tube (porosity of disk "medium," height above disk about 110 mm, capacity about 45 ml). Excess fixative is removed by rinsing with 5 ml acetone and decanting. The filter is then filled with pure acetone, which is allowed to run freely by gravity. When the tube is about half full it is refilled to the top with additional acetone. This process is repeated once again. By the end of an hour the filter will have emptied and the dehydration process will have been completed.

As soon as the last of the acetone has disappeared through the disk, the tissues are cleared with xylene. This may be carried out conveniently by pouring xylene into the Alliin tube. When the tissues become translucent they are removed immediately, since too long an exposure to xylene will render them brittle. Kidney slices may become translucent in 15 min, whereas spleen slices may require 45 min.

The cleared slices are placed in small, labeled, galvanized screen baskets, 1 in. in diameter and 3 in. high. These are placed in 250-ml beakers containing

melted paraffin (Tissuemat, mp, 54°–56° C) and maintained in a vacuum oven at 58° C and 560 mm Hg pressure. A desiccator, in an ordinary thermostatically controlled oven, connected to a Cartesian manostat with a vacuum filter pump, provides a satisfactory vacuum oven. After 30 min in the vacuum oven, the tissues are placed in a fresh beaker of pure paraffin and kept at 58° C for 30 min.

After the infiltration is completed, the slices are embedded in paraffin in the usual manner. It has been found useful on occasion to embed many tissues in the same block, using a cardboard box as a mold. If the box is large (3" × 3" or larger) care must be taken to use flexible cardboard sides to permit the paraffin to contract on cooling without splitting the block.

In the method described, dehydration is first favored by the presence of 80% alcohol in the fixing solution. It is greatly intensified by the technique which makes use of the sintered glass filters. This procedure tends to promote a high concentration gradient between the water in the tissue and the acetone outside by constantly allowing the partly diluted acetone to escape through the bottom of the filter while simultaneously replacing it with fresh fluid from above.

The use of a partial vacuum helps to remove the xylene and thus to favor the infiltration by a paraffin that is comparatively pure. Too high a vacuum tends to separate and disrupt the tissues.

The method has been used routinely in our laboratory for more than a year. By its use, it is possible to start with fresh tissues in the morning and to complete the preparation of sections for microscopic study before the end of the working day. Good results have been obtained with such difficult preparations as those showing clearly the cilia of the respiratory epithelium or the ciliated brush borders of the proximal convoluted tubules of the kidney.

## An Apparatus for Determining Bone Density by Means of Radioactive Strontium ( $Sr^{90}$ )<sup>1</sup>

F. Gaynor Evans, Carl C. Coolbaugh,  
and Milton Lebow

Departments of Anatomy and Engineering Mechanics,  
Wayne University, Detroit, Michigan

During investigations upon regional differences in the physical properties of the compacta of the leg bones of man and the dog the density was one of the properties studied. Since one of the investigators (CC) is studying the effects, in the dog, of alterations in the blood supply of the femur, it was necessary to have a method for detecting very slight differences in density. It was therefore decided to determine the density by the percentage transmission of  $\beta$ -rays through the bone samples.

<sup>1</sup> This investigation was supported (in part) by a research grant from the National Institutes of Health, USPHS.

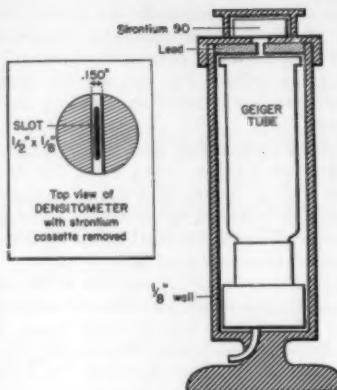


FIG. 1. Diagram of apparatus for measuring bone density by means of radioactive strontium ( $Sr^{90}$ ).

$\beta$ -rays were selected since nuclear theory shows that the percentage of their transmission by any material is proportional to the logarithm of the density of the material. The curve obtained by plotting the log of the intensity (epm) against the weight per unit area (density  $\times$  thickness) is a straight line. Within the maximum and minimum limits of the weight per unit area all materials will fall upon this curve.

Radioactive strontium ( $Sr^{90}$ ), with a half-life of 25 years, was used as a source of the  $\beta$ -rays, and the percentage of them transmitted through a bone sample was recorded with a Geiger counter. The concentration of the  $\beta$ -ray source was equivalent to approximately  $1/100 \mu\text{c}$ , which is far below the danger threshold for human tissue. Thus the operator could use the apparatus for 8 hr a day continuously without harmful effects. The main part of the apparatus is illustrated diagrammatically in Fig. 1.

The apparatus consists of a closed brass cylinder for the Geiger tube (TGC 2) and a brass cassette for the radioactive material. The head of the cylinder is lined with lead and has a groove for the sample, which is held in place by small clips. In the bottom of the groove is a small slit, so that the  $\beta$ -rays penetrating the portion of the sample overlying the slit can reach the Geiger tube. The cassette fits tightly to the head of the cylinder but can be removed so that the head can be changed to accommodate a sample of a different size. Reference marks on the head and the cassette insure that the geometry of the radioactive material and the sample is always the same. Four aluminum strips of known density but of varying thickness were used to calibrate the densitometer.

Each day, before testing the bone samples, the random (background) epm was obtained without the strontium. Then, with the strontium in place, the epm was taken for each aluminum strip. Three readings were taken for each strip and the final epm was based on the average. In all cases the net epm, obtained by subtracting the background epm from the average,

was used in computations. The curve for the aluminum strips was then plotted on semilogarithmic single-cycle paper. This curve (Fig. 2) was then used to determine the weight per unit area ( $\text{g}/\text{cm}^2$ ) of the bone samples.

The net epm for each bone sample was located on the calibration curve of the aluminum strips, and the weight per unit area of the sample read directly from the curve. The weight per unit area of the sample divided by its thickness gives its density in  $\text{g}/\text{cm}^3$ . The thickness of the samples was measured with a micrometer to the nearest five  $10/1000$  of an inch. A minimum of 4,000 counts/sample was taken. With this method density differences of less than 1% could be detected.

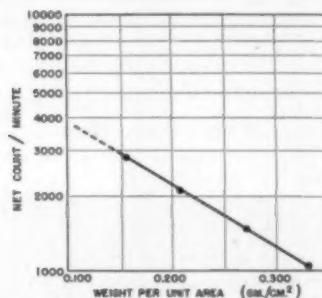


FIG. 2. Calibration curve of aluminum strips.

The samples of human bone were obtained from the compacta of the anterior, posterior, medial, and lateral quadrants of the proximal, middle, and distal thirds of the femur and tibia. Because of their smaller size the human fibulas were simply divided into thirds and the dog femurs into quadrants. The samples were then reduced to a standardized size in a milling machine and by use of emery cloth. The specimens were air-dried at room temperature before testing. In current studies on the dog femur, the samples are placed in a desiccator for 24 hr before testing. This provides a greater standardization of conditions.

As an example of the results obtained by use of the apparatus, the density values obtained by two of the authors (FGE and ML) in a preliminary study of samples of human bone may be cited. The samples were obtained from the bones of a relatively young man, a middle-aged man, and an old man. In all, 137 samples from the femurs, 135 samples from the tibias, and 26 samples from the fibulas were tested. In each bone (Fig. 3) the average density decreased with the increased age of the individual whose bones were studied. The decrease in density was greatest in the fibulas and least in the femurs. Some regional differences in the density within a single bone (Fig. 4) were also noted. The density of the proximal third of all three bones was practically identical, but the middle third of the tibia and the distal third of the femur were the most dense regions of the respective bones. The average density of all the samples from each bone

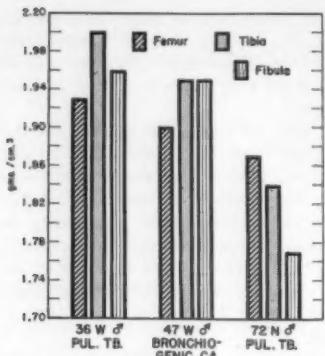


FIG. 3. Average density values ( $\text{g}/\text{cm}^3$ ) for 298 samples of compact human bone with respect to the age of the individual from whom the samples were taken.

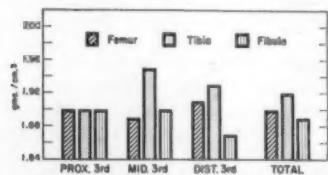


FIG. 4. Average density values ( $\text{g}/\text{cm}^3$ ) of 298 samples of compact human bone with respect to the region of the intact bone from which the samples were taken.

was greatest in the tibia and least in the fibula. The variation between the most and the least dense third of each bone was 1.0% in the femurs, 2.6% in the tibias, and 1.6% in the fibulas. The average density of the tibias was 1.0% greater than that of the femurs and 1.6% greater than that of the fibulas. The average density of the femurs was 0.5% greater than that of the fibulas.

The sensitivity of the apparatus is also illustrated by the initial results obtained by one of the authors (CCC) in an investigation of the effects of a reduction in the blood supply on the density and other physical properties of bone. This work is being done on the dog, the only other species so far studied. The blood supply to one femur was reduced by operative procedures, the opposite femur serving as the control or normal bone. The density values for 48 samples of normal bone taken from the femurs of 6 dogs are presented in Table 1.

The density changes present 48 hr after the blood supply to the right femur had been reduced by ligation of the nutrient artery plus a periosteal decapsulation of the entire femoral shaft are shown in Table 2.

In density studies the accuracy with which the thickness of the specimens can be controlled is an important factor. Among the 298 samples of human bone whose density was determined, the thickness of 87% of them was within the standardized range ( $.08 \pm .01$  in.); 12% were .06-.07 in. thick; 6% were

.05-.06 in. thick; and 5% were .04-.05 in. thick. The thickness of the samples from the dog femur was controlled with a similar degree of accuracy.

The average values for the specific gravity of human compact bone found by some of the earlier investigators are: 1.934, Wertheim (1); 1.9304, Krause and Fisher (cited by Hulsen, [2]); 1.936, Aeby (cited by Rauber [3]); 1.901 for the fresh femur and tibia of a man 30 years of age and 1.825 for a woman 56 years of age, Rauber (3); and 1.933 for the femur, Hulsen (2). Mack, cited by Keys, *et al.* (4), measured the density of bone, by means of roentgenograms, in 32 living subjects at 24 weeks of starvation and after 6 and 12 weeks of rehabilitation. The bones studied were the left little finger, the left femur, and the left calcaneum. The average values, in terms of equivalent ivory thickness (cm), for the region of the femur about 5 cm proximal to its most distal tip (i.e., its distal third), for the semistarvation and normal subjects were 2.571 and 2.243, respectively, for one group and 2.462 and 2.300, respectively, for a second group. Our average density values ( $\text{g}/\text{cm}^3$ ) for the human bones are 1.90 (femur), 1.92 (tibia), and 1.89 (fibula). The values given by Mack, *et al.* (4) for human bone are not directly comparable to those obtained by the authors, since the former were taken from living individuals. Consequently, the overlying tissues, fat, blood, and other constituents of the marrow, as well as superimposition of bone, would be involved. These factors may account for the higher density values obtained by Mack. The previous investigators mentioned did not study regional differences in the density of individual bones or the influence of blood supply upon the density of bone.

The final results of these studies of the density of human bone and how the density of the dog femur is influenced by a reduction in the blood supply to the bone will be published separately and more extensively elsewhere.

TABLE 1  
DENSITY ( $\text{g}/\text{cm}^3$ )—NORMAL

Quadrant	Right femur	Left femur	Difference	% Difference
Anterior	1.790	1.810	0.02	1.10
Posterior	1.835	1.800	0.035	1.90
Medial	1.810	1.830	0.02	1.09
Lateral	1.840	1.830	0.01	0.50

TABLE 2  
DENSITY ( $\text{g}/\text{cm}^3$ )—PARTIALLY AVASCULAR AND NORMAL—48 HR AFTER OPERATION

Quadrant	Right femur (operated)	Left femur (normal)	Difference	% Difference
Anterior	1.94	1.98	0.04	2.02
Posterior	1.84	1.89	0.05	2.64
Medial	1.80	1.93	0.13	6.73
Lateral	1.86	1.94	0.08	4.12

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## Some Effects of High-Intensity Ultrasound on Tobacco Mosaic Virus<sup>1</sup>

Nelson Newton<sup>2</sup>

Battelle Memorial Institute, Columbus, Ohio

Several investigators have reported the effect of sonic and ultrasonic frequencies on tobacco mosaic virus. Early reports of the exposure of tobacco mosaic virus to sonic frequencies were made by Stanley (1) and by Takahashi and Christensen (2). Exposure of tobacco mosaic virus to sonic and ultrasonic frequencies was reported by Kausche, Pfankuch, and Ruska (3), who showed that the virus could be broken into shorter particles by suitable exposure, with the infectivity reduced. Oster (4) exposed tobacco mosaic virus to a frequency of 9,000 c. He found that, as the time of exposure was increased, the basic virus unit, 280 mμ long, was broken into fragments one half and one fourth the original length.

This is a report of some effects of high-intensity ultrasonic waves, oscillating at a frequency of 7 Mc, on the physical structure and infectivity of tobacco mosaic virus. This is a much higher frequency than has previously been used in ultrasonic exposure of viruses.

The juice from Turkish tobacco plants infected with tobacco mosaic virus was purified by the usual technique, involving alternate low- and high-speed centrifugation, and was finally suspended in a phosphate buffer at pH 7. A suspension consisting largely of the basic virus unit 280 mμ long was obtained in this manner.

The ultrasonic vibrations were produced at the face of a quartz crystal ground to vibrate at a frequency of 7 Mc. The crystal controls the oscillator circuit which drives it. Exposure of the virus suspension was made inside a thick-walled lucite cylinder of 5-cc capacity suspended with its lower end about 10 mm above the horizontally mounted crystal. Both ends of the exposure tube were sealed by a 0.003-in.-thick acetate membrane. The entire transducer and exposure tube assembly was mounted under transformer oil having a high dielectric constant. By this arrangement, the ultrasonic waves, originating at the crystal, pass upward through a layer of rapidly circulated ice-cooled oil into the exposure tube, out its upper end, and back into the oil reservoir, where they are deflected and dispersed by screen baffles. Although the

outside of the exposure tube was cooled to approximately 10° C, some internal heating did occur, as indicated by a mercury thermometer inserted into the tube following treatment.

To quantitatively evaluate the effect of ultrasonic irradiation upon the infectivity of the virus, Scotia bean plants were infected at the time secondary leaves began to appear. Infection was produced by rubbing one of each pair of primary leaves with an aluminum spatula dipped in ultrasonically treated virus suspension and the other with untreated virus suspension. To aid infection, all leaves were first dusted with No. 600 Carborundum. Infectivity comparisons were made on the basis of 10 replications.

After exposure to ultrasonic energy, microdrop samples of the virus suspensions were deposited upon a thin film formed by evaporating a 0.2% solution of Formvar in ethylene dichloride. The microdrop sample was not allowed to evaporate to dryness, but was removed with a micropipette after standing several minutes. This deposit was then lightly platinum-shadowed in *vacuo* before being photographed in the Universal Model RCA electron microscope.



FIG. 1. Tobacco mosaic virus,  $\times 20,000$ . Electron micrographs show effects of high-intensity ultrasound. Unexposed virus, consisting primarily of units 280 mμ long, is shown at left; highly fragmented virus (fragments 20 mμ–40 mμ long) is shown at right.

Fig. 1 shows the results obtained by treatment at the maximum energy output of the oscillator. This high degree of fragmentation of the virus was accompanied by cavitation in the liquid. Experience has shown that the degree of fragmentation revealed by the electron micrographs was directly proportionate to the amount of cavitation as indicated by the number and volume of released gas bubbles. Heating of the virus suspension by ultrasonic energy was not in itself sufficient to inactivate the virus.

Lesion counts made on Scotia bean plants after inoculation of the leaves with unexposed virus and virus exposed to ultrasound for 3.3 min showed a reduction of approximately 95% in the infectivity of the virus exposed to ultrasound.

Using lower intensity levels, between approximately 140 w and 180 w power input, and varying the time of exposure, the following results have been demonstrated:

a) Ultrasonic irradiation of "aged" virus suspension produces an increase in virus infectivity through dispersion of aggregated clusters of virus rods.

<sup>1</sup>This work was jointly supported by the U. S. Public Health Service and Battelle Memorial Institute.

<sup>2</sup>The author wishes to acknowledge the capable technical assistance of John Kissel.

b) Highly end-to-end aggregated virus is disaggregated primarily into basic virus units 280 m $\mu$  long with a subsequent increase in the infectivity of the ultrasonically exposed virus.

c) At somewhat higher energy levels, statistically significant measurements show a tendency for the basic infective unit, 280 m $\mu$  long, to fracture, first at a constant distance from the end of the virus rod, with subsequent random fragmentation as the power is increased. This indicates a structural weakness at one definite point in the virus rod.

It is felt that, with further study and refinements of techniques, there is a definite possibility of preparing viral and bacterial vaccines by exposure to ultrasound which may be superior in the treatment of disease to those produced by the usual procedures, since the method of inactivation is physical and therefore probably less likely to alter antigenic properties than in the case of chemical inactivation. Ultrasonic inactivation of microbiological materials may also furnish a means of "uncovering" desirable antigens.

By the use of comparatively low-energy ultrasonic treatment, "aged" vaccines may be reactivated and their useful period possibly extended.

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### Report on Fossil Vertebrates from the Upper Magdalena Valley, Colombia

Donald E. Savage

Museum of Paleontology,  
University of California, Berkeley

The field-work program for collection of fossil vertebrates in the Upper Magdalena Valley (Department of Huila, Colombia) during the summer of 1950 was sponsored jointly by the Associates in Tropical Biogeography at the University of California and by the Servicio Geológico Nacional de Colombia. The writer was paleontologist for the party. Diego Henao Londoño, geologist for the Servicio, managed the field group. Oliver Pearson, of the Museum of Vertebrate Zoology at the University of California, joined us in Huila to facilitate his work on the zoological studies in the upper Magdalena. Stanley G. Smith, of the Botany Department, was also attached to our field party for a month and was able to carry on the program of plant studies.

This was the second year in which one or more representatives from the Museum of Paleontology had participated in the jointly sponsored program. In the summer of 1949, R. A. Stirton and Robert W. Fields joined with Sr. Henao for the initiating of detailed stratigraphic studies; but prior to that time, in 1944 and 1945, Stirton and Royo y Gomez had collected a large assemblage of fossil vertebrates from the region. The most important paleontological discoveries

TABLE 1  
THE LA VENTA FAUNA—LATE MIocene

Class, Diplopoda	Order, Lepidostomidae
	Family, Lepidostomidae
Class, Teleostomi	Order, Cypriniformes
	Suborder, Siluri (catfish)
	Unidentified teleost
Class, Amphibia	Order, Anura
	Family, Leptodactylidae
Class, Reptilia	Order, Chelonia
	Suborder, Pleurodira
	Family, Pelomedusidae
	Suborder, probably two genera
Order, Sauria	Family, Iguanidae
	Family, Teiidae
Order, Serpentes	Family, Boidae
	Order, Sbecosuchia
	Family, Sbecidae ( <i>Sebecus</i> )
Order, Eosuchia	Family, Alligatoridae
	Family, Crocodylidae
	Family, Stomatosuchidae
	Family, Gavialidae
Class, Aves	Order, unidentified
	Class, Mammalia
	Order, Marsupialia
	Family, Didelphidae
	Family, Borhyaenidae (cf. <i>Borhyaena</i> , <i>Lycopsis</i> , and <i>Cladoscitis</i> )
Order, Chiroptera	Family, Phyllostomatidae (n. gen. and n. sp. Savag [8])
	Order, Primates
	Family, Cebidae
	Subfamily, Pitheciinae ( <i>Cebupithecia sarmientoi</i> Stirton and Savage [6])
	Subfamily, Alouattinae ( <i>Homunculus tatacoensis</i> Stirton [9]; <i>Homunculus</i> sp. Stirton [9])
	Subfamily, Cebinae ( <i>Neosaimira fieldsi</i> Stirton [9])
Order, Edentata	At least two families and four genera
	Order, Condylarthra
	Family, Didelodontidae
Order, Litopterna	Family, Macrauchenidae (two genera)
	Family, Proterotheriidae (two genera)
Order, Notungulata	Family, Leontiniidae
	Family, Toxodontidae
	Family, Interatheriidae (n. gen. and n. sp. Stirton and Savage [7])
	Family, Hegetotheriidae
Order, Astrapotheria	Family, Astrapotheriidae (two genera)
	Order, Sirenia
	Family, Trichechidae ( <i>Potamosiren magdalenensis</i> Reinhardt [10])

made by the 1950 field party were: a complete cranium of a toxodont, skeletal parts of a leontiniid,

mandible of a large gavial-like crocodile, cranium and skeletal parts of a large mylodont ground sloth, cranium of a leontiniid, ventrally complete cranium of an astrapothere, and a complete cranium and mandible of a juvenile interatherium.

*Earlier work in the area.* The nonmarine Miocene beds, Honda formation, in the north-central district of Huila have yielded the most complete fossil vertebrate assemblage yet known in northern South America. Oil geologists had known of bones in these deposits and had made reports of these occurrences to their companies by 1938. Royo y Gomez (1) and Stirton (2) have discussed the reports of these geologists. The first published report on a fossil vertebrate from Huila seems to have been Cabrera's (3) paper on a new species of astrapothere from the Tertiary beds. Mook (4) described a new species of crocodylian from an unspecified locality not far west of Neiva, capital of Huila. Brother Ariste (Mauricio Rollot) collected the crocodylian in 1920; he also collected the astrapothere named by Cabrera. The crocodile was thought to be possibly Cretaceous in age; however, Royo y Gomez (5) points out that the specimen probably came from the Honda formation (Tertiary). Royo y Gomez (5) reported on crocodylian, chelonian, rodent, and notungulate specimens from sandstones of the "Honda superior," which were found north of the village of Villavieja along the trail to San Alfonso. Royo y Gomez (1) has also published a preliminary survey of the Villavieja Miocene badlands, including an introductory list of fossil vertebrates and a generalized section of the Honda sediments. Personnel from the University of California now have additional papers in press on the fossil vertebrates of this area; these papers are indicated in Table 1.

*Honda formation and La Venta fauna.* The fossiliferous beds northeast of Villavieja have been identified as the Honda formation because of lithologic similarity and corresponding stratigraphic, structural, and physiographic position to the Honda in its type locality. The beds here were apparently laid down as flood-plain deposits in a system of streams and include red-colored mudstone members and gray to brown sandstones, mudstones, and conglomerates. In this area more fossils seem to have accumulated in the gray mudstones than in the other types of sediments, although one ferruginous sandstone was notably fossiliferous.

Fossil vertebrates of late Oligocene age have been collected from the Honda formation approximately 50 miles north of the Villavieja district. It becomes apparent, then, that components of the Honda formation in different geographic provinces were not laid down at the same time. In order to distinguish the Honda lithogenetic unit from any concept of geologic time based on the fossil vertebrates, Stirton and Savage (6,7) employ the name "La Venta fauna" for the special late Miocene vertebrate assemblage from the Honda beds at Villavieja. The list given in Table 1 will indicate our present knowledge of the systematics of the assemblage and will also indicate status of our

research program on the fauna. Wann Langston, Jr., has kindly furnished preliminary identifications of the reptiles, amphibians, and fish.

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### Effects of Various Analgesics on Inflammatory Edema Resulting from Silver Nitrate Injection

Annette La Belle and John A. Tornaben

The Wellcome Research Laboratories,  
Tuckahoe, New York

It was noted during analgesia experiments on silver nitrate-irritated rat joint preparations (1) that the ankles of aspirin-treated rats appeared considerably less swollen than ankles of the controls. This action of aspirin has been made the subject of the present investigation. Similar studies have been made on other compounds for the sake of comparison.

The animals used were male CF or RF albino rats weighing approximately 350 g and maintained on Rockland rat diet. Irritation was produced by injecting 0.2 ml 1%  $\text{AgNO}_3$  into the ankle joint. The rats were anesthetized with ether to avoid struggling. To inject the left ankle, the rat was placed on its right side and the needle inserted into the posterior aspect of the hind leg approximately 1 cm above the heel and directed down into the joint. Care was taken not to puncture the visible superficial blood vessels. Because of the large volume of solution, the fluid spread through the heel and paw. A  $\frac{1}{4}$ -cc tuberculin syringe with a 23-gauge needle was found satisfactory. Silver precipitates of tissue fluids tended to accumulate in the syringe and cause the plunger to stick, but this difficulty was avoided by rinsing out the syringe with distilled water between injections and dissolving out the precipitate with nitric acid when necessary.

Somewhat similar animal preparations have been employed by Winter (2) and Selye (3) to observe the effect of pretreatment with cortisone on the development of inflammatory edema. To produce the swelling, Winter injected 0.1 ml 0.5%  $\text{AgNO}_3$  and Selye 0.1 ml of various strengths formaldehyde beneath the plantar aponeurosis of the hind paw of the rat.

Shortly after injection the tissues of the foot and ankle became red and swollen and developed all the signs of acute inflammation. The joint became very sensitive to movement and within 24–48 hr a typical

response consisting of squealing and struggling was elicited from the rat whenever the foot was flexed ventrally with firm pressure. A sterile abscess usually developed at the site of the injection.

Anteroposterior and mediolateral measurements of the ankle were made with calipers 48 hr after injection, and the circumference was calculated, assuming the ankle at this level to be rectangular. An example of the great increase that occurs in the dimensions of the ankle is illustrated in Table 1. The average circumference was 2.49 cm in the controls and 4.51 cm in the injected rats.

TABLE 1  
EFFECT OF  $\text{AgNO}_3$  INJECTION ON SIZE OF ANKLE JOINT OF RAT

Treatment	No. rats	Circumference 48 hr after injection (in cm)
Uninjected	8	2.49 ± 0.20
Injected with $\text{AgNO}_3$	8	4.51 ± 0.27

The compounds aspirin, acetophenetidin, and sodium gentisate were administered by stomach tube, 1 mg/g, 40% suspensions in 2% starch solutions, 24 hr after the  $\text{AgNO}_3$  injections. The control rats received 2% starch solution. Measurements were made at 24 hr after the tube feedings. It was evident from the marked reaction of the rats to flexion of the joint that they were obtaining no analgesic effect from these compounds at this time. The results of the measurements are summarized in Table 2. Aspirin and acet-

TABLE 2  
EFFECTIVENESS OF VARIOUS DRUGS IN REDUCING INFLAMMATORY EDEMA RESULTING FROM INJECTION OF 1%  $\text{AgNO}_3$  INTO ANKLE JOINT OF RAT

Compound	Method of administration	Dose (mg/g)	No. rats in group	Ave circumference* and SD (in cm)	Diff (in cm)	P†
Aspirin	Oral	1.0	6	3.45 ± 0.32	0.71	< 0.01
Starch control	"	—	7	4.16 ± 0.18		
Acetophenetidin	"	1.0	5	3.64 ± 0.35	0.52	< 0.01
Starch control	"	—	7	4.16 ± 0.18		
Sodium gentisate	"	1.0	8	4.40 ± 0.16	0.11	> 0.05
Starch control	"	—	8	4.51 ± 0.27		
Morphine	Subcutaneous	0.01	5	4.03 ± 0.06	0.08	> 0.05
Control	taneous	—	5	4.11 ± 0.29		
Demerol	Subcutaneous	0.10	5	3.88 ± 0.19	0.23	> 0.05
Control	taneous	—	5	4.11 ± 0.29		

\* Measurements made 48 hr after  $\text{AgNO}_3$  injection.

† Test of significance was made by calculating statistic t.

phenetidin reduced the swelling significantly, but sodium gentisate did not. Sodium gentisate is less toxic

than the other two compounds, and it is possible that better results would have been obtained with higher doses, but on a milligram for milligram basis it was less effective.

Morphine sulfate, 0.01 mg/g as 0.5% solution, and demerol hydrochloride, 0.1 mg/g as 5.0% solution, were each injected twice subcutaneously, once 24 and once 48 hr after  $\text{AgNO}_3$  irritations. Measurements were made 2 hr after the last injection. At this time these narcotics were at the peak of their analgesic activity and no response at all was given by the rat to firm flexion of the swollen joint. The circumferences of the ankles at this time are included in Table 2. Neither compound produced a statistically significant change.

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#### Levels of Nucleotide in the Blood during Shock

George T. Hoffmann, Antonio Rottino, and Harry Albaum

Hodgkin's Disease Research Laboratory,<sup>1</sup>  
St. Vincent's Hospital, New York, and  
Brooklyn College, Brooklyn, New York

The work of Green (1) and his collaborators is based on the hypothesis that shock is produced by the release of adenine nucleotides from tissue into the blood stream. This idea was suggested by observations that when substances like ATP and related compounds were injected into the intact animal shocklike symptoms occurred. Green was never able to prove his hypothesis because specific methods for the determination of blood ATP and related substances were not available to him.

During the past 18 months we have been studying levels of adenine nucleotides in normal persons and patients with Hodgkin's disease. Blood levels in a number of other pathological conditions were also measured for comparison, and among these were samples from patients suffering from various kinds of shock (Table 1).

The method used in these studies is that of Albaum and Lipschitz (2), a modification of a procedure devised by Kalekar (3, 4), in which ATP, ADP, and AMP are measured spectrophotometrically after successive dephosphorylation and deamination to inosinic acid. In addition to measuring blood levels of these adenine compounds, we also determined the absorption spectrum of the blood filtrates between 2300 Å and 2800 Å.

In the blood samples from patients in shock there were no significant alterations in the levels of ATP,

<sup>1</sup> Supported in part by grants from the National Cancer Institute, USPHS, the American Cancer Society, and the Damon Runyon Memorial Fund.

ADP, and AMP, nor were any of these substances found in the serum. In some cases, however, there was an alteration in the absorption spectrum of the blood filtrate characterized by a flattening of curve between 2500 Å and 2600 Å, producing a broad absorption maximum. In two cases this alteration was so marked that sharp peak absorption was found to be around 2500 Å, rather than at 2600 Å, the normal level (Fig. 1). Moreover, it was found that in the blood of

TABLE 1

Cause of shock	Blood pressure	Hematocrit	Wavelength of peak absorption (in Å)*	ATP†		
				ATP	ADP	AMP
Massive arterial hemorrhage	0/0	50	2510	—	—	—
Multiple fractures	135/55	41	2450-2600‡	—	—	—
Crush (no fractures)	60/30	43	2560	—	—	—
Coronary occlusion	40/0	45	2570	6.6	0	0
Coronary occlusion	0/0	47	2570	6.9	2.0	0
Bleeding peptic ulcer	80/60	20	2570	4.1	0	0
Diabetes mellitus	44/24	51	2570	2.4	0	0
Coronary occlusion	0/0	49	2500-2600‡	7.7	0	0
Ruptured ectopic pregnancy	40/0	33	2500	4.3	0	0
Ruptured esophageal varices	90/40	23	2500-2600‡	1.9	0	0
Acute alcoholism	80/60	41	2500-2600‡	6.5	0	0

\* Normally, peak absorption is between 2580 Å and 2600 Å.  
† Normal ranges established by us are:

ATP, 4.0-9.0 mg% expressed as adenine;  
ADP, 0.0-2.0 mg%;  
AMP, 0.0-2.0 mg%.

‡ Flat plateau.

a patient in deep shock caused by rupture of an ectopic tubal pregnancy the aberration of the absorption spectrum was reversible. Peak absorption was at 2500 Å when the patient was first admitted to the hospital in profound shock. Twenty-four hr later, after operation, control of hemorrhage, and transfusion, the absorption curve reverted to the normal pattern (Fig. 2).

Although we were unable to confirm Green's hypothesis directly, since circulating ATP, ADP, and AMP were not increased, the alteration in the absorption spectrum suggested an increase in blood level of some substance, closely related to adenine nucleotides, which absorbs maximally in the vicinity of 2500 Å. Inosine nucleotides absorb at this wavelength, and

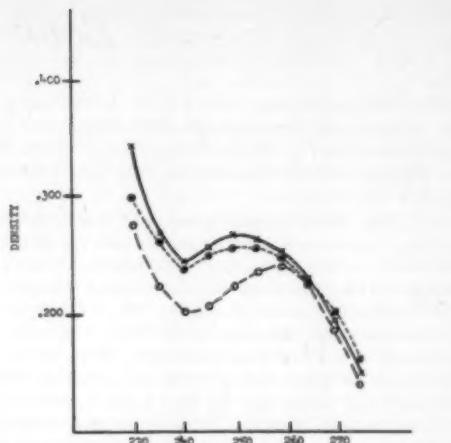


FIG. 1. ○—○, normal blood; ×—×, normal blood with added inosinic acid, 15 mg%; ●—●, blood of patient in shock. Wavelength in m $\mu$ .

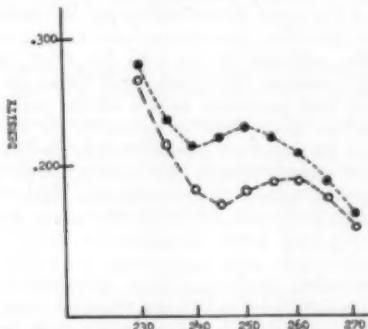


FIG. 2. ●—●, shock from ruptured ectopic pregnancy; ○—○, 24 hr after operation and transfusions. Wavelength in m $\mu$ .

they can be formed by deamination of adenine nucleotides.

To test the effect of increased amounts of inosine on the absorption spectrum of blood, we added varying amounts of sodium inosine monophosphate to normal blood and found that an amount corresponding to a blood level of 15 mg% produced an alteration in the absorption spectrum exactly corresponding to that seen in cases of severe shock (Fig. 2).

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## Book Reviews

**Die Binnengewässer.** Bd. XVIII, *Verbreitungsgeschichte der Süßwassertierwelt Europas*. August Thienemann. Stuttgart: Verlag Schweizerbart, 1950. 809 pp., 249 fig. Paperbound, DM 92; clothbound, DM 95.

In this, the sixteenth volume of the well-known series, Thienemann, who began the series with one of the best existing statements of limnological principles, returns with an immense zoogeographical treatment of the fresh-water fauna of Europe. The book begins by considering the distribution of *Mysis relicta* as an example of ecological zoogeography. Two sections of just over 120 pages then give the principles of modern ecology and limnology as they appear relevant to zoogeographical studies. Valuable sections on archaic elements in the fresh-water fauna of the world and on the preglacial fresh-water fauna of Europe follow. An attempt is then made to identify preglacial elements in the existing European fauna. The interesting snails of the genus *Melanopsis* in the hot springs of Hungary and Italy provide one convincing group of examples, and part of the cave fauna, of obvious antiquity, another. The fascinating fauna of Lake Ochrid is also considered in this context and is followed by an all-too-brief excursion to the Caspian. Just over 100 pages are then devoted to the effects of the Pleistocene glaciation. The available paleontological material, largely from interglacial beds, is summarized, and the main types of distribution believed to be of glacial origin are described. Some of the stratigraphy may need slight correction in the light of recent work. The extraordinary disjunct distribution of genera such as *Hucho*, *Rhodeus*, and *Misgurnus*, which occur in eastern Asia and in Europe but not in Siberia, is emphasized and attributed to Siberian glaciation; the evidence for this is, however, hardly indicated, and the whole problem of the development of the desert areas which in part produce the disjunction is not considered. The postglacial re-invasion of glaciated regions is dealt with at length, special consideration being given to the Baltic types of distribution. The last 50 pages of the detailed discussion summarize in a masterly way the introduction into Europe accidentally or intentionally of 26 species of fresh-water organisms, ranging from the hydrozoan *Cordylophora caspia* to the muskrat.

Thienemann's book is an essential part of the library of anyone interested in zoogeography. It should be studied meticulously and critically by all students of North American fresh-water fauna. The author adopts a reasonably conservative view, which leads him to reject some absurdities but also, perhaps, makes him undercritical of many plausible and apparently well-established conclusions that actually rest on little enough evidence. One also misses the evolutionary point of view that is rejuvenating zoogeographic research in America. In spite of this feeling

that the work is in a certain rather vague sense a little old-fashioned, it is a veritable mine of information. One puts it down in gratitude to its distinguished author for so literally sharing with us the fruits of his immense learning. The prospective purchaser is advised that the outlay of three additional marks on the clothbound edition will prove a sound investment.

G. E. HUTCHINSON

*Osborn Zoological Laboratory  
Yale University*

**Patterns of Sexual Behavior.** Clellan S. Ford and Frank A. Beach. New York: Harper, 1951. 307 pp. \$4.50.

Attitudes and outlook upon matters pertaining to sexuality, the reproductive system, and the function of reproduction have undergone a tremendous change in the United States within the past two decades. Emerging from a period when it was highly questionable for a scientist to study basic phenomena pertaining to sex, and conditions under which it was unlawful to send through the mails, or otherwise disseminate, information pertaining to birth control, the year 1932 saw the publication of the first edition of *Sex and Internal Secretions* (revised in 1939). Here, attention centered chiefly upon physiological processes, mainly in the lower animals, and a vast amount of information on basic biological processes, especially as they related to rapidly developing knowledge concerning the hormones, was introduced. Individuals could thus begin openly to give consideration to the workings of this system, as they could much earlier to the digestive, excretory, or nervous system. Although a guaranteed publication subsidy was required for this volume, it immediately came into wide use among scientists and medical experts, was widely commended, and both editions were rapidly exhausted.

Then, in 1948, the first of a projected series of studies on problems relating to sex, *Sexual Behavior in the Human Male*, appeared. Although replete with charts, tables of statistics, and carefully compiled data obtained by the interview method, the book rapidly became a nonfiction best seller, and additional studies are being eagerly awaited.

*Patterns of Sexual Behavior* marks another milestone in the elimination of provincialism and permits scientists, physicians, and intelligent laymen to bring into retrospect, from a wide cultural viewpoint, many problems on which dependable information has been lacking. It is now possible to view the problem from a background of differing cultures, since concrete information is utilized from data on 190 human cultures, from the Arctic Circle to Australia. One may also consider the problems from an evolutionary background owing to the abundance of information pertaining to subhuman primates, as well as to all classes

of lower mammals. Laboratory studies are called upon rather heavily to illuminate the basic physiology involved. The book has been compiled by a well-trained anthropologist, familiar with a great many existing cultures, and by one of the foremost experimentalists in sex behavior problems. The authors have been most successful in merging their different experiences into a well-integrated general treatise, to the extent that the separate disciplines merely become a part of the generalized picture, developed against a wide evolutionary background. It is authentic, full of diversified information, and masterfully presented.

Chapters deal with "The Nature of Coitus," "Types of Sexual Stimulation," "Circumstances for Coitus," "Attracting a Sex Partner," "Sexual Partnerships," "Homosexual Behavior," "Relations between Different Species," "Self-stimulation," "Development in the Individual," "Feminine Fertility Cycles," "Other Physiological Factors in Sex Behavior," with a closing chapter on "Human Sexual Behavior in Perspective." A glossary of 350 terms, including location and a short characterization of different cultures, a bibliography of some 200 references, and an index make the book understandable to the layman and a valuable reference source to the scientist.

As a characteristic treatment of the different chapters, the discussion of "Homosexual Behavior" opens with a general introduction and setting in antiquity, followed by discussion of attitudes and frequency among both men and women in the United States. The chapter continues with a treatment of attitudes existing in 76 other human cultures. Similar behavior is then traced through the subhuman primates, and examined for lower mammalian species, with a closing summary for the chapter. The biological, evolutionary, and physiological aspects of sex behavior are thus brought together in a commendable attempt to assist in a better understanding of the behavior and attitudes toward sex in human society.

CARL R. MOORE

Hull Zoological Laboratory  
The University of Chicago

*Researches in Binocular Vision.* Kenneth N. Ogle. Philadelphia-London: Saunders, 1950. 345 pp. \$7.50.

In this publication, there is a readable and well-presented account of the results of many years of research by Dr. Ogle and his colleagues at the Dartmouth Eye Institute. We are fortunate to have this work, as probably no other single group has devoted so much time and effort to the understanding of these extraordinary phenomena.

The treatise is neither comprehensive nor exhaustive, as the intention was only to present the knowledge of the subject matter gained from investigations at Dartmouth. The greater part of the material is concerned with direct investigations on the perceptual process of spatial localization. Although many aspects of binocular vision are not discussed, the section dealing with

aniseikonia will be of clinical interest. The author has organized and integrated his investigations into the general body of knowledge bearing on the subject.

Broadly speaking, the contents are divided into four parts. The first part presents an introduction to the localization of the horopter and the influence on the horopter by introducing magnification into one eye. In Part II the author reports on investigations concerned with the extent of Panum's fusional area, fixation disparities, fusional amplitudes, and cyclotorsional eye movements.

Part III presents some of the work for which the Dartmouth group attracted great interest. This work concerned the distortions introduced in the spatial localization of walls, floors, and ceilings when changes are made in the relative magnification of the images of the two eyes. The last part treats certain aspects of aniseikonia, from which the clinician will gain some insight into the perceptual problems.

The student of vision will find this a valuable reference.

HENRY G. WAGNER

Department of Biophysics  
The Johns Hopkins University

*Mathematical Engineering Analysis.* Rufus Oldenburger. New York: Macmillan, 1950. 426 pp. \$6.00.

This is a new kind of textbook with a new delimitation of subject matter for which the new expression "mathematical engineering analysis" has been chosen. In about 400 pages all branches of mechanics and certain parts of thermodynamics, electricity, and magnetism are covered. Obviously some kind of selection had to be made. The author's main idea seems to have been to give only the simplest basic formulas, which usually serve as a point of departure for the construction of mathematical theories. He also wants, however, to present results of a practical nature. Thus, in his first chapter, after a discussion of the most primitive notions of particle mechanics, he shows on page 27 a complete cutaway illustration of an automobile shock absorber which suggests that the preceding definitions and laws should be applied to it. In the same vein the book continues to offer simple formulas such as that heat flux is proportional to a temperature difference or to a temperature gradient. The reader is then encouraged to apply a theorem for heat transfer to complicated devices like gas turbine blades. Nowhere in the book is a theoretical setup carried through to such an extent that a student would learn how more than the most immediate consequences could be drawn from the basic laws by the use of methods that are usually called "mathematical analysis."

As every teacher knows, the difficulty of formulating laws and theorems in a clear, concise, and correct way, so that a beginner can successfully handle them, is enormous. The author is not always lucky in choosing his formulations; what, for instance, "Laws 1.4 and 1.5" on page 10 mean is hardly clear. In the chapter on aerodynamics one single theorem (14.1) is

pronounced stating that under certain conditions a once-irrotational motion stays irrotational.

The reviewer is inclined to believe that the fragmentary approach chosen by the author might be useful on a certain level of instruction. The obvious danger of the method, however, is that a student will be led by it to kind of "speaking knowledge" of mathematical physics and might then believe that he has learned the essentials. On the other hand, a more mature reader, well grounded in the elements of physics, will enjoy the wealth of interesting examples, the great variety of problems discussed, and, above all, the skillfulness and many-sidedness of the author.

Division of Engineering Sciences  
Harvard University

R. v. MISES

**Petroleum Geology.** Kenneth K. Landes. New York: Wiley; London: Chapman & Hall, 1951. 660 pp. \$10.00.

Professor Landes, chairman of the Geology Department of the University of Michigan, has done an outstanding job in compiling the vast amount of information found in his book. The inclusion of many full-page maps (34) has enhanced its value, especially to the geologist.

The book is divided into three distinct parts. The first, "Techniques of the Petroleum Geologist," concerns itself primarily (76 pp.) with exploration methods and secondarily (24 pp.) with exploitation procedures. The information is of a broad general nature and merely acquaints the reader with or reminds him of the subject matter. The field is well covered, however, and with few exceptions emphasis is proportional to the method or the procedure.

Part 2, "Geologic Occurrence of Petroleum" (202 pp.), summarizes the more important theories concerning the origin and accumulation of oil, and is illustrated with many full-page maps drawn from authentic sources. The probable causes of migration are discussed, as well as the possible effects of migration on the physical and chemical properties of oil. The various types of traps are considered and are well illustrated by specific field examples. Adequate bibliography is included for reference work.

Part 3, "Present and Future Oil Supplies" (306 pp.), considers the domestic and foreign distribution of petroleum along with a modest concluding chapter on future oil supplies. Domestic occurrence is treated by individual states. Often three separate and identical-scale maps of each state are included, showing, respectively, structure and oil and gas fields, oil and gas fields, and index map of principal fields. In most cases the three maps could be condensed to one, or two at the most, without causing confusion or losing accuracy—thus the rather unusual criticism of superfluous or overillustration may apply here. If these excess illustrations had been replaced by selected maps of gravity, magnetic, and seismograph surveys, which play such an important part in petroleum exploration, the volume would have gained in balance.

All in all the book fills a much-needed void in its field. It is an important contribution, rivaled only by C. G. Lalicker's excellent *Principles of Petroleum Geology*, which, however, is more restricted in scope.

M. G. FREY

Department of Geology  
University of Cincinnati

## Scientific Book Register

*Einführung in das Studium der Physik.* Wolfgang Finkelnburg et al. Heidelberg, Germany: Carl Winter, Universitätsverlag, 1950. 119 pp. DM 4.95; bound DM 6.95.

*Animal Evolution: A Study of Recent Views of its Causes.* G. S. Carter. London: Sidgwick and Jackson; New York: Macmillan, 1951. 368 pp. \$4.50.

*Encyclopedia of Chemical Reactions: Fe, La, Pb, Li, Mg, Mn, Hg, Mo, Nd,* Vol. IV. C. A. Jacobson, Ed. New York: Reinhold, 1951. 790 pp. \$14.00.

*Catalogue of the Fossil Cephalopoda: The Ammonoidea of the Trias (II), Part V.* L. F. Spath. London: British Museum (Natural History), 1951. 228 pp. £1 15s.

*Weed Seedlings.* Anna P. Kummer. Chicago: Univ. Chicago Press, 1951. 435 pp. \$5.00.

*The Chemistry of Heterocyclic Compounds: Six-Membered Heterocyclic Nitrogen Compounds with Four Condensed Rings.* C. F. H. Allen et al. New York-London: Interscience, 1951. 345 pp. \$10.00.

*Advanced Fluid Dynamics and Fluid Machinery.* R. C. Binder. New York: Prentice-Hall, 1951. 426 pp. \$8.00.

*Advances in Protein Chemistry, Vol. VI.* M. L. Anson, John T. Edsall, and Kenneth Bailey, Eds. New York: Academic Press, 1951. 549 pp. inc. cumulative index to Vols. I-V. \$9.50.

*The Fischer-Tropsch and Related Syntheses: Including a Summary of Theoretical and Applied Contact Catalysis.* Henry H. Storch, Norma Columbie, and Robert B. Anderson. New York: Wiley; London: Chapman & Hall, 1951. 610 pp. \$9.00.

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## *Association Affairs*

### **Los Angeles Meeting of the Pacific Division, AAAS**

**Robert C. Miller**

*California Academy of Sciences, San Francisco*

The 32nd annual meeting of the Pacific Division was held at the University of Southern California, Los Angeles, June 18-23. Eighteen associated and affiliated societies participated in the sessions, at which more than 400 scientific papers were presented. The total registered attendance was 1,088.

This was the division's third Los Angeles meeting, and the second to be held at the University of Southern California, the previous occasion being in 1923. To those who had the pleasure of attending these two meetings on the same campus 28 years apart, it was a gratifying experience to note the growth and progress made in the interim both by the Pacific Division and by the host institution.

The university is exceptionally well equipped to entertain such a scientific gathering. Registration was carried on out-of-doors in the School of Architecture's inner courtyard, which also served admirably as a place for friends to meet and for informal discussions. It was surrounded by rooms in which scientific books, instruments, and other exhibits were displayed.

The fine new University Commons was conveniently at hand, serving excellent meals and providing dining rooms for the luncheons and dinners of various societies. The near-by Town and Gown Club afforded an attractive setting for the Monday afternoon tea, at which Fred D. Fagg, Jr., president of the University of Southern California, and Mrs. Fagg, received members and guests of the division and associated societies. Comfortable, attractively modern, and well-equipped lecture rooms were available for the scientific sessions.

On June 19, 20, and 21 there were evening addresses by outstanding authorities in their respective fields as follows: Ruy Finch, of the Hawaiian Volcano Observatory, on "Mauna Loa in Eruption;" Charles H. Danforth, professor of anatomy, Stanford University, and president of the Pacific Division, on "The Significance of Human Anatomical Variations;" and Harold C. Urey, University of Chicago, on "The Temperatures of the Oceans Sixty Million Years Ago."

The Divisional Symposium, held Tuesday morning, was on "Oceanographic Exploration in the Pacific." The following papers were presented: "Geological and Geophysical Exploration of the Pacific," by Roger Revelle, Scripps Institution of Oceanography; "Oceanographic Exploration in the Arctic," by John P. Tully, Pacific Oceanographic Group, Nanaimo, B. C.; "Exploration of the Coral Atolls," by Harry S. Ladd, U. S. Geological Survey, Washington, D. C.; "Oceanographic Exploration of the Fisheries," by

Milner B. Schaefer, Inter-American Tropical Tuna Commission, Scripps Institution.

Another event of general interest was the symposium on "Air Pollution and Plant Life," which was a joint session of the American Society for Horticultural Science, Western Section; American Society of Plant Physiologists, Western Section; Botanical Society of America, Pacific Division; Western Society of Naturalists; and Western Society of Soil Science. Papers were presented by: A. J. Haagen-Smit and Helen Garman, of the California Institute of Technology; O. C. Compton, of Oregon State College; and Alden S. Crafts and E. E. Wilson, of the University of California, Davis.

All the symposia, in fact, dealt with topics of unusual interest, as indicated by the following examples: "Meteorological Physics" (American Meteorological Society); "The Role of Ecology in Solving Water Pollution Control Problems" (Ecological Society of America, Western Section); "Physiological Genetics of Higher Plants" (joint session of American Society for Horticultural Science, American Society of Plant Physiologists, Botanical Society of America, and Western Society of Naturalists). The American Society of Limnology and Oceanography, Pacific Section, held two symposia, one on "Biological Aspects . . .," the other on "Inorganic Aspects of the Marine Environment." At a symposium entitled "The Part Played by Society Members in International Soil Science," the Western Society of Soil Science heard reports of soil survey and land reclamation work in Belgium, Holland, Greece, Turkey, and Bolivia.

Registrants did not spend all their time listening to and discussing scientific papers. There were special demonstrations, field trips, and excursions. Among points of interest visited were the Griffith Observatory and Planetarium, the Los Angeles County Museum, the Rancho La Brea Tar Pits, the California Institute of Technology, the Palomar Observatory, and the Citrus Experiment Station of the University of California at Riverside.

Exhibits of wide and varied interest were set up by the U. S. Corps of Engineers, Los Angeles County Flood Control District, Department of Meteorology, UCLA, North American Weather Consultants, Ninth Weather Squadron of March Air Force Base, Southern California Marine Borer Council, American Nature Study Society, Allan Hancock Foundation Library, Society of Systematic Zoology, American Society of Ichthyologists and Herpetologists, Junior Herpetological Society, Los Angeles County Schools, Los Angeles County Air Pollution Control District, and Los Angeles City Schools, Department of Elementary Agriculture and Nature Study. In addition, 28 exhibits of books, instruments, and laboratory equipment were presented by commercial firms.

Deserving of special mention was the schedule of

women's activities, which included a reception and a mixer for registrants and their families, and special tours of Los Angeles, Pasadena, Deauville Beach, television and radio centers, and other points of interest.

Local arrangements were under the supervision of John W. Mehl, professor of bacteriology in USC, who was assisted by a large general committee and nine subcommittees. For the hard work of these representatives of the host institution, the Pacific Division expresses its deep appreciation of the excellent facilities and services provided.

At the meeting of the council of the division on June 20, action was taken to revise the constitution to bring it into greater conformity with that of the national organization, by providing for a president-elect, a president, and a retiring president.

H. A. Speehr, of the Carnegie Institution of Washington, Stanford University, was elected president, and C. D. Shane, director of the Lick Observatory, president-elect. James E. Knott, of the University of California at Davis, and Ivan Pratt, of Oregon State College, were elected to membership on the Executive Committee; and George Zentmeyer, of the University of California at Riverside, and K. O. Emery, of the University of Southern California, were elected members-at-large of the Divisional Council.

After discussion of suitable dates, it was agreed that the next annual meeting of the division will be held in Corvallis, Oregon, June 18–21, 1952, at the invitation of Oregon State College.

On motion, by unanimous vote of the council, the Society for Systematic Zoology was declared an affiliated society of the Pacific Division.

The council discussed the geographical boundaries of the Pacific Division, which under its constitution includes the states of California, Idaho, Nevada, Oregon, Utah, and Washington; the territories of Alaska and Hawaii; and the province of British Columbia. It was pointed out that members in Alaska desire an Alaskan Division, that some members in Montana wish to have that state included in the territory of the Pacific Division, and that there is some overlapping of interest of associated societies of the Pacific and the Southwest divisions. Howard A. Meyerhoff, AAAS administrative secretary, who, with Raymond L. Taylor, assistant administrative secretary, was present at the meeting, was asked to take these matters up through the regular channels to obtain appropriate action at the national level.

Dr. Meyerhoff stated that the national Executive Committee had under consideration the possibility of holding the annual meeting of the AAAS in San Francisco in December 1954. After discussion, it was voted that the proposal for a national meeting in the West in December 1954 be heartily approved.

Societies participating in the Los Angeles meeting were:

American Meteorological Society; American Nature Study Society, Pacific Division; American Phytopatho-

logical Society, Pacific Division; American Society for Horticultural Science, Western Section; American Society of Ichthyologists and Herpetologists, Western Division; American Society of Limnology and Oceanography; American Society of Plant Physiologists, Western Section; Association of Pacific Coast Geographers; Astronomical Society of the Pacific; Botanical Society of America, Pacific Division; Ecological Society of America, Western Section; Herpetologists League; Meteoritical Society; Pacific Southwest Association of Chemistry Teachers; Society of American Bacteriologists, Southern California Branch and Northern California-Hawaiian Branch; Society for Experimental Biology and Medicine, Pacific Coast Section and Southern California Section; Western Society of Naturalists; Western Society of Soil Science.

Attendance included 1,088 registered members and guests. Though predominantly a divisional meeting, there were delegates from all regions of the continental U. S., and all continents were represented, as indicated by the following tabulation:

GEOGRAPHIC DISTRIBUTION OF REGISTRANTS*			
Arizona	26	Montana	6
Arkansas	1	Nebraska	5
<b>California</b>	<b>856</b>	<b>Nevada</b>	<b>5</b>
Colorado	11	New Mexico	7
Connecticut	2	New York	4
District of Columbia	6	North Carolina	2
Florida	2	North Dakota	3
<b>Idaho</b>	<b>2</b>	<b>Ohio</b>	<b>1</b>
Illinois	8	Oklahoma	1
Indiana	1	<b>Oregon</b>	<b>27</b>
Kansas	1	Pennsylvania	2
Louisiana	1	Rhode Island	1
Maryland	5	Texas	3
Massachusetts	4	<b>Utah</b>	<b>25</b>
Michigan	2	Virginia	1
Mississippi	1	<b>Washington</b>	<b>35</b>
Missouri	3	Wyoming	3
Total, continental United States		1,059	
Argentina	1	England	3
Australia	2	Hawaii	8
<b>British Columbia</b>	<b>9</b>	Philippines	1
Denmark	1	Puerto Rico	1
Egypt	2	Union of South Africa	1
Total, foreign or overseas		29	
Grand total		1,088	

\* Bold-face type indicates registration from the Pacific Division, which totaled 959, or 88%.

It is impressive to note that this divisional meeting, held near the southwest corner of its territory, attracted an attendance of 109 from 27 states outside the Pacific Division and from the District of Columbia. This is exactly the same number of states outside the division's territory represented at the 1950 Salt Lake City meeting. There were 266 registrants from Los Angeles, many from the host institution, USC, and from UCLA. There were registrants from 129 other communities throughout California, including Davis with 67, Berkeley and Riverside each with 58, Pasadena 48, and La Jolla and Stanford-Palo Alto each with 27 registrants. The number from Hawaii and other overseas points was particularly gratifying.

## News and Notes

### The Hawaii Marine Laboratory

ON APRIL 21 the official opening of the Coconut Island branch of the Hawaii Marine Laboratory was celebrated. The laboratory is an integral part of the University of Hawaii and consolidates under one name the long-established Marine Biological Laboratory at Waikiki Beach, the biological laboratories devoted to marine sciences on the main campus of the university, and the newly constructed branch at Coconut Island, Oahu.

The laboratory's program includes both teaching and research, with the Waikiki branch and the laboratories on the main campus of the university devoted primarily to instruction, and the Coconut Island branch exclusively to research. These new facilities greatly enhance the effectiveness both of the academic program in marine and fishery biology leading to the bachelor's, master's, and doctor's degrees, and of the research program in marine sciences. Ample physical separation of instruction and research has been achieved so that neither interferes with the other, and both activities may proceed throughout the year at a marine laboratory.

Staff members of the University of Hawaii will have first priority on laboratory space, with second priority going to staff members of the University of California because of an agreement between the two universities for mutual assistance in marine research in the central Pacific. Remaining space is available to qualified visiting investigators upon application. Application blanks and a brochure describing the details of the laboratory and the regulations for visiting investigators are available from the director.

Coconut Island is situated in the protected waters of Kaneohe Bay, about 15 miles from Honolulu. The bay, about 15 square miles in extent, opens broadly to the sea over a protective elevated reef. The northeast trades sweep directly into it, thus forcing a rapid exchange of the bay and oceanic waters, creating ranges of salinity from brackish conditions, close to stream mouths, to almost normal ocean conditions in the more open areas. The central part of the bay consists of many channels which are of varying widths and surround coral platforms that reach the surface of the water at low tide. Each platform is fringed by an extensive growth of corals, comprising the finest development of corals in the Hawaiian Islands. The fringing reef platform surrounding Coconut Island is replete with coral heads and intervening sandy areas, thus providing one of the richest collecting areas in Hawaii. Contributing greatly to the varied ecological situations in the vicinity of the island are the true oceanic conditions found just outside the bay, within a half-hour launch trip from the laboratory.

Biologically, Hawaii is situated at the extreme eastern periphery of the rich Indo-Pacific faunal area. Over 2,000 species of invertebrates and over 500 spe-

cies of fish are known to inhabit the reef and inshore areas. The laboratory and its environs offer ideal facilities for studies on all phases of the biology of tropical and subtropical fish, turtles, and invertebrates. The zooplankton of the bay waters and of the neritic waters just outside is exceedingly varied and abundant, in contrast with that of the oceanic waters farther offshore. The finest oceanic bird rookery in the Hawaiian archipelago (except for some of the leeward Hawaiian Islands) is located just outside Kaneohe Bay on the islet of Moku Manu. A half-hour launch trip from the laboratory places the observer in an unparalleled outdoor laboratory for studies of several species of terns, shearwaters, petrels, boobies, and frigate birds.

Hawaiian shores abound in algae of all major groups. Especially abundant are chlorophycean genera such as *Ulva*, *Cladophora*, *Caulerpa*, *Codium*, and *Halimeda*. The last four offer special possibilities as subjects for physiological research. Among the Phaeophyceae, prominent genera are *Ectocarpus*, *Sargassum*, *Padina*, and *Stictyota*. The red algae are represented by many genera, perhaps the most abundant of which are *Laurencia*, *Rhodymenia*, *Liaogora* (mostly calcareous), and the corallines. The agariferous genus *Gelidium* is of special interest. The blue-green algae and the diatoms are, of course, abundant.

The laboratory building contains two large rooms, one for general biological work and one for physiological studies, and two smaller general-purpose laboratories. Laboratory tables are available for 12 to 16 persons. Workshops, storerooms, a darkroom, and a long concrete porch with aquarium tables complete the working facilities; the remainder of the building consists of living quarters. In addition to the laboratory, there is a residence hall, net house, dock, marine railway, six tidal ponds of varying dimensions and depths, a battery of large glass-fronted aquaria, and five partially sunken concrete tanks. Two separate salt-water systems supply the large outdoor tanks and the salt-water tables at the laboratory. Pumps and motors for the sea-water systems are arranged in duplicate for automatically alternating duty, so that there is no storage or recirculation of sea water, but rather a continuous pumping mechanism. Stainless steel, antimony-free lead, and cast iron have been used in the sea-water systems so that the water delivered is free from toxic contaminants and suitable for the most critical embryological studies.

The laboratory is stocked with routine supplies and equipment. Certain equipment such as pH meters, colorimeters, Warburg-Barcroft apparatus, Van Slyke apparatus, cathode-ray oscilloscope, microscopes, microtomes, etc., will be furnished when needed from the supply room on the main campus.

Field equipment available includes a 46-foot research vessel, the *Salpa*, which has a live well and hoisting gear for all types of biological and oceanographic work.

graphic collecting. Routine gear, such as plankton nets of various kinds and sizes, bathythermographs, Nansen water bottles, reversing thermometers, current meters, diving gear, etc., is stored at the laboratory. In cooperation with the Territorial Division of Fish and Game and the Pacific Oceanic Fishery Investigations, larger vessels for work at sea are often available to qualified investigators.

The proximity of the extensive libraries of the university, the Bernice P. Bishop Museum, the Hawaiian Sugar Planters Association Experiment Station, and the Pineapple Research Institute makes it unnecessary to maintain a separate library at the laboratory. The Hawaii Marine Laboratory issues two series of publications. "Contributions from the Hawaii Marine Laboratory" are technical papers published in suitable journals and numbered serially. A series of mimeographed leaflets, entitled *Hawaii Marine Laboratory News Circular*, reports on the progress of current research and is sent to anyone interested.

The Advisory Board consists of Albert W. Bellamy, Division of Life Sciences, University of California at Los Angeles; Vernon E. Brock, Territorial Division of Fish and Game; Robert W. Hiatt (chairman of the board and director of the laboratory), University of Hawaii; Carl L. Hubbs, Scripps Institution of Oceanography; George F. Pappenfuss, University of California; and Albert L. Tester, University of Hawaii.

The resident research staff includes Albert H. Banner (biological oceanography); Vernon E. Brock (ichthyology, fishery biology); George W. Chu (parasitology); Maxwell S. Doty (marine botany); William A. Gosline, III (ichthyology); Robert W. Hiatt (marine invertebrates, ecology); Sidney C. Hsiao (experimental embryology, physiology); John L. Kask (fishery biology); Donald C. Matthews (invertebrate zoology); O. E. Sette (fishery biology); Albert L. Tester (fishery biology, biometrics); and Pieter van Weel (comparative physiology).

ROBERT W. HIATT

*Hawaii Marine Laboratory*  
University of Hawaii

### Scientists in the News

William H. Adolph, who recently returned from the Peking Union Medical College, is leaving at the end of the summer to serve on a nutrition research project under the auspices of the Point IV program in the eastern Mediterranean area. Dr. Adolph will make his headquarters at the School of Medicine, American University, in Beirut, and will be concerned both with the development of a research program and with the training of laboratory personnel.

Paulo C. A. Antunes has been appointed assistant director of the Pan American Sanitary Bureau, replacing John R. Murdock, who recently resigned to return to his post in the U. S. Public Health Service. Dr. Antunes, who has been in charge of all the bureau's public health programs for the past three years, is on leave of absence from the School of Hygiene and

Public Health of the University of São Paulo, where he holds the position of dean.

E. J. Baldes, of the Mayo Clinic, has been named Chevalier de l'Ordre National de la Légion d'Honneur by the French government, "as a token of gratitude for outstanding services . . . rendered to medical sciences, especially . . . in the field of aeronautics. . . ."

Maurice L. Brashears, Jr., district geologist, of the Mineola, N. Y., office of the Ground Water Branch, Water Resources Division, U. S. Geological Survey, has returned from his assignment as a visiting expert consultant on water supplies in Japan.

Paul S. Burgess, for 20 years dean of the College of Agriculture and director of the Agricultural Experiment Station at the University of Arizona, has resigned to return to the Department of Agricultural Chemistry and Soils in the Agricultural Experiment Station. He is being replaced by Phil S. Eckert, of the Food and Agriculture Division of the ECA and Point IV programs in Washington, D. C.

Robert L. Corsbie has been appointed chief, Civil Defense Liaison Branch of the Atomic Energy Commission's Division of Biology and Medicine. He will be responsible for liaison with the Federal Civil Defense Administration and other government and private agencies on problems having to do with the effects of atomic weapons, methods of protection against hazards associated with atomic energy, methods of treatment for radiation injuries, and methods for building structures to minimize the radiation and blast effects of atomic weapons.

Reuben Frodin has been appointed executive dean for the four-year and professional colleges of the University of the State of New York. Mr. Frodin, who was administrative assistant to Robert M. Hutchins, president of the University of Chicago, and assistant dean of the college, has been consultant to the State University since last September.

Hyman I. Goldstein, of Camden, N. J., has been elected an honorary member of the Italian Gastroenterological Society (Rome); he was also made medical historian of the New Jersey Gastroenterological Society at its recent annual meeting at Asbury Park. Dr. Goldstein is an honorary member of the Belgian Society of Gastroenterology, and foreign correspondent of the National French Gastroenterological Society and of the Cuban Society of Cancerology.

Lucy Armistead Goldthwaite, who from 1905 to 1942 was the director of the Library for the Blind of the New York Public Library, and who since has been a member of the staff of the American Foundation for the Blind, has retired. In 1946 the foundation honored Miss Goldthwaite for outstanding service to the blind with the award of the Migel Medal. She was a member of the New York State Commission for the Blind and represented the American Library Association on the

Uniform Type Commission, which obtained adoption of the universal Braille type.

**William E. Gordon** was recently appointed professor of research at the George Warren Brown School of Social Work of Washington University. His appointment, to conduct basic research in social work, is the first such to be made by a school of social work.

**Donald E. Gregg**, chief of the Cardio-Respiratory Diseases Department, Army Medical Service Graduate School, was one of the lecturers at the CIBA Foundation conference on visceral circulation in London. The program included addresses by 47 of the outstanding leaders in this field from England, the U. S., Canada, Scotland, Ireland, Belgium, Sweden, Denmark, and Germany. Other U. S. speakers were D. H. Barron, of Yale University Physiology Laboratory; S. E. Bradley, of Presbyterian Hospital in New York; and S. R. M. Reynolds, of the Carnegie Institution of Washington.

**D. R. Hartree**, professor of mathematical physics at the University of Cambridge, is in Australia, at the invitation of the Commonwealth Scientific and Industrial Research Organization and the Australian National University, to discuss mathematical computing with officers of CSIRO and of the Department of Supply, to take part in a conference on automatic computing machines which CSIRO is arranging at the University of Sydney, and to visit the universities of Sydney, Melbourne, Adelaide, and Tasmania.

**Thomas C. Holy**, authority in the fields of school finance, school buildings, and school surveys, is retiring as director of Ohio State University's Bureau of Educational Research. A member of the staff of the bureau for 24 years, Professor Holy has been its director during the past nine years.

**Henry A. Imus**, head, Psychophysiology Branch, ONR, has recently transferred to the ONR branch office in London, where he will serve as general psychologist. **Sherman Ross**, from the Department of Psychology, University of Maryland, is now attached to the Psychophysiology Branch in Washington. **William Consolazio**, formerly head of the Biochemistry Branch, has joined the National Science Foundation, and **Louis Levin**, of the ONR branch office, New York, has replaced him as head of the Biochemistry Branch.

Fisher Scientific Co. has recently appointed **Samuel W. Levine** as director of development. A researcher in x-ray and emission spectroscopy, the properties of petroleum reservoirs, and hydrocarbon thermodynamics, he was also active in the development of microwave radar systems in World War II at the MIT Radiation Laboratory.

Recent visitors at the Communicable Disease Center, USPHS, Atlanta, Ga., were: **Kuang Chi Liang**, malariologist, Taiwan Provincial Malaria Research Institute, Taipeh, Formosa; **Abdul Rahim**, director general, Malaria Society, Kabul, Afghanistan; **Pramern Chan-**

**davimol**, chief, Communicable Disease Control Division, Department of Public Health, Bangkok.

**Syotaro Mizuno**, professor of orthopedic surgery at the Osaka Municipal University School of Medicine and director of the Osaka Vocational Training and Rehabilitation Center for the Handicapped, was a recent visitor at the Kessler Institute.

**William H. Newman**, professor of business administration, has been named the first Samuel Bronfman professor in democratic business enterprise in the Graduate School of Business at Columbia University.

**John H. Ottemiller**, acting chief of the Division of Library and Reference Services of the Department of State, has been named associate librarian of the Yale University Library. He will succeed **David H. Clift**, who will become executive secretary of the American Library Association.

**S. C. Pan**, formerly with Joseph E. Seagram & Sons at Louisville, Ky., is now with the Research Department of E. R. Squibb & Sons, New Brunswick, N. J.

**Roland R. Renne**, Montana State College president, has been appointed to head a government mission to build up the economy of the Philippines. He is chief of ECA's special technical and economic mission.

**José Carlos Rodriguez** is in Washington, D. C., for a year's in-service training with the U. S. Geological Survey in engineering geology, under the sponsorship of the Department of State Point IV program. He is one of five young professors from the University of São Paulo, Brazil, to come to the Survey for training.

The Spingarn Medal, presented annually for the highest achievement of an American Negro, was awarded to **Mabel Keaton Staupers**, of New York, for her successful efforts to integrate Negro nurses into American life as equals. The presentation was made at the annual convention of the National Association for the Advancement of Colored People. Mrs. Staupers was largely responsible for bringing about the commissioning of Negro nurses in the armed services in World War II. She served as executive secretary and president of the National Association of Colored Graduate Nurses, and last winter she was instrumental in dissolving the association because it had achieved the democratic aims to which it had been dedicated.

**Harry Stinson** has been appointed assistant professor and acting chairman, Department of Biology, College of William and Mary.

**Walter P. Taylor**, wildlife research supervisor, Fish and Wildlife Service, leader, Oklahoma Cooperative Wildlife Research Unit, and professor of zoology, Oklahoma Agricultural and Mechanical College, will retire Sept. 1, after 35 years of service. He plans to make his home in Claremont, Calif., and to devote his time to studies in ecology, conservation education, and wildlife management.

## Education

The study-plus-work education plan has worked so well at **Antioch** that the college is seeking a way to extend the benefits to its faculty through a teaching-working arrangement. During the 1951-52 academic year community leaders in about 20 centers in the U. S. will meet in a series of regional conferences to help develop a plan through which faculty members can alternate between teaching and working. Antioch will ask for help in making its thirty-year-old general education program of even more practical value to its students. Financed by the Rockefeller Foundation, the college is conducting a self-study of this program.

Staff of the **Bureau of Mines North Central Experiment Station** on the University of Minnesota campus has been increased from seven to twelve persons as a result of expanded defense programs, including the development of practical methods to recover manganese, sulfur, and iron from low-grade manganese-bearing iron ore and iron sulfide deposits. New staff members are Roy T. Sorensen and Paul A. Wasson, metallurgists; Alfred H. Wendelbo and Don C. Seidel, chemical engineers; and Cedric T. Erickson, laboratory mechanic. Carl E. Wood is in charge of the Region V Metallurgical Division.

A committee of seven American applied research experts left Aug. 5 for Germany under the auspices of **ECA**, to investigate the country's needs for industrial research and development and make recommendations to the German government. The group, headed by Harold A. Vagtborg, president of Southwest Research Institute, is composed of Jesse E. Hobson, Robert R. Adams, William A. Casler, Calvin O. Williams, Hugh B. Buhrman, and Maurice Holland. Late this month, they will meet in Paris with European and American officials to arrange for similar surveys in Austria, Belgium, France, Italy, The Netherlands, and Norway.

The **University of Illinois**, the **Children's Bureau**, the **Public Health Service**, and the **Division of Rehabilitation (FSA)** will conduct an \$83,500 demonstration program in the training of doctors, nurses, social workers, and technicians in the Consultation Clinic for Epilepsy, which is part of the Department of Psychiatry, College of Medicine, University of Illinois. Patients will be chosen on the basis of special problems in diagnosis and treatment and will come from all sections of the country.

A new curriculum in feed technology will start this fall at **Kansas State College**, although complete building facilities will not be ready before 1953-54. The first two years' work will not require special feed technology equipment.

An Institute for Fluid Dynamics and Applied Mathematics is being held at the **University of Maryland**, with S. R. de Groot as visiting research professor. The seminars are held on Tuesday and Thursday evenings and will extend through Sept. 20.

## In the Laboratories

John L. Schmidt has joined the Pharmacology Department of **Abbott Laboratories** in North Chicago, as senior research pharmacologist.

The **Charles Beseler Company** has appointed Allan Finstad, Navy Training Aids head, educational director. For the past five years Mr. Finstad has acted as civilian head of the Bureau of Naval Personnel Training Aids Section.

**Dow Corning Corporation**, whose plant and main office remain at Midland, Mich., has moved its New York offices to 600 Fifth Ave.

**Heinicke Instrument Corporation** is moving from Rochester, N. Y., to Hollywood, Fla., in an expansion program requiring more manufacturing space. It is also contemplating the opening of a branch in Puerto Rico.

The **High Voltage Engineering Corporation**, Cambridge, Mass., has appointed Davis R. Dewey II vice president. Dr. Dewey was previously technical director of American Research and Development Corporation, Boston.

Directors of the **Interlake Iron Corporation** have elected R. W. Thompson president, director, and a member of the executive committee, succeeding the late Edward L. Clair. J. Paul Fagan was advanced from vice president and treasurer to executive vice president and treasurer, and J. H. McDaniel from general works manager to vice president in charge of operations.

R. C. Coupland, (USAF, ret.), has been appointed manager of a new product development department of the metal products division of **Koppers Company, Inc.**

The **Midwestern Communicable Disease Center Services** have recently moved into a new headquarters and laboratory building at 3900 Eaton St., Kansas City, on the campus of the University of Kansas School of Medicine, which made the facilities available. LeGrand Byington is medical officer in charge of the staff of 54 located in Kansas City and at field stations in several states.

**Parke, Davis & Company** will replace without charge all its products damaged or destroyed by flood in retail drug stores throughout Missouri, Kansas, and Oklahoma. The company has already sent 32,000 pounds of disinfectant and supplies of typhoid-paratyphoid vaccine and other medicines to the flood-stricken area.

**Raytheon Manufacturing Company** has appointed Nathaniel B. Nichols, authority on servomechanisms and automatic controls, as manager of its research division. Dr. Nichols has been teaching general electrical engineering and courses dealing with analog and digital computers at the University of Minnesota.



Written by

**George H. M. Lawrence**

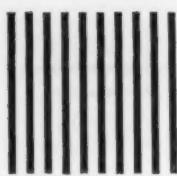
*Professor of Botany,  
Bailey Hortorium, Cornell University*

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By Luther S. West, Professor and Head of Department of Biology, Northern Michigan College of Education; Major, Medical Service Corps, USAR

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- Medical and economic aspects of the housefly—flies and human disease, public health relations, myiasis, some beneficial aspects.
- The fly as an experimental animal—field, museum, and laboratory techniques for collecting and preserving all stages; standard testing procedures.
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## Publications Received

*Some Digenetic Trematodes, including Eight New Species from Marine Fishes of La Jolla, Calif.* Harold W. Manter and Harley J. Van Cleave. Proc. U. S. National Museum, Vol. 101, No. 3279. Smithsonian Institution, GPO, Washington, D. C. 1951.

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*Veterans Administration Conference on Cortisone Research: A Symposium, August 15 and 16, 1950.* Merck & Co., Inc., Rahway, N. J. 1951.

*A Year's Experience with Dethmor (Warfarin) for Rat and Mouse Control.* S. B. Penick and Co., New York. *Ácidos Nucleicos do Fígado Em Algumas Condições Experimentais (Liver Nucleic Acids in Some Experimental Conditions).* Gilberto G. Villela. Gráfica Milone Ltda., Rio de Janeiro. 1951.

*Acthar, the Armour Laboratories Brand of Adrenocorticotrophic Hormone (ACTH).* General Practice Summary. Armour Laboratories, Chicago, Ill.

*The Aestivating Eggs of the Red-Legged Earth Mite, Halotydeus destructor (Tucker).* K. R. Norris. Bull. No. 263. Commonwealth Scientific and Industrial Research Organization, Melbourne. 1950.

*Arabies-Afrikaanse Studies: I. 'N Tweetalige (Arabiese en Afrikaanse) Kategismus.* A. Van Selms. Mededeel. Koninkl. Nederland. Akad. Wetenschap., Nieuwe Reeks, Deel 14, No. 1. *De Evolutie der Javaanse Geschiedschrijving.* C. C. Berg. No. 2. *Proceedings.* Vol. LIV, No. 2. *Series A, Mathematical Sciences. Series B, Physical Sciences. Series C, Biological and Medical Sciences.* Koninkl. Nederland. Akad. Wetenschap., North-Holland Pub. Co., Amsterdam. 1951.

*Botany of Southeastern Yukon Adjacent to the Canol Road.* A. E. Porsild. Bull. No. 121, Biol. Ser. No. 41. Minister of Resources and Development, Ottawa, Canada. 1951. \$1.00.

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*Furniture Beetles: Their Life-History and How to Check or Prevent the Damage Caused by the Worm.* British Museum (Natural History) Economic Series, No. 11. *Clothes Moths and House Moths: Their Life-History, Habits, and Control.* 5th ed. No. 14. Trustees of the British Museum, London. 1951. 9 d.

*Commercial Fertilizers. Report for 1950.* H. J. Fisher. Bull. 544. Dec. 1950. *Effect of Slash Mulch and Slash Burn on Pine and Spruce Plantings.* Herbert A. Lunt. Bull. 548. April 1951. *The 54th Report on Food Products and the 42nd Report on Drug Products, 1949,* H. J. Fisher. Bull. 549. April 1951. Connecticut Agricultural Experiment Station, New Haven.

*The Dakota Bark House.* Indian Leaflets 1-4 of the Science Museum. Science Museum, St. Paul, Minn. 1951.

*Defense Programs of Selected Federal Agencies Affecting Colleges and Universities.* Margaret C. James, William J. McGlothlin, and Harry B. Williams. Committee on Defense Programs, Board of Control for Southern Regional Education, Washington, D. C. March 1951.

*Lighting and the Nation's Welfare.* National Information Committee on Lighting, Cleveland, Ohio. 1951.



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 Sept. 3-7. American Chemical Society (Annual). New York.  
 Sept. 4-8. Second Alaskan Science Conference. Alaska Division, AAAS, and University of Alaska. Mt. McKinley National Park.  
 Sept. 5-7. Mycological Society of America. University of Minnesota, Minneapolis.  
 Sept. 5-7. National Agricultural Chemicals Association. Essex and Sussex Hotels, Spring Lake, N. J.  
 Sept. 7-9. Western Society of Electroencephalography (Annual). Olympia Hotel, Seattle.  
 Sept. 8-9. International Union of Pure and Applied Chemistry. New York.  
 Sept. 8-12. Ecological Society of America. University of Minnesota, Minneapolis.  
 Sept. 9-14. International Gerontological Congress. Hotel Jefferson, St. Louis.  
 Sept. 10-12. American Institute of Biological Sciences (Annual). University of Minnesota, Minneapolis.  
 Sept. 10-13. International Congress of Pure and Applied Chemistry. New York.  
 Sept. 10-14. Instrument Society of America. Sam Houston Coliseum, Houston, Tex.  
 Sept. 12-14. American Fisheries Society (Annual). Rochester, New York.  
 Sept. 12-14. Biological Photographic Association (Annual). Kenmore Hotel, Boston.  
 Sept. 12-14. National Petroleum Association. Hotel Traymore, Atlantic City.  
 Sept. 13. World Metallurgical Congress. Detroit, Mich.  
 Sept. 13-15. American Society of Limnology and Oceanography (Annual). Rochester, New York.  
 Sept. 14-15. International Union of Pure and Applied Chemistry. Washington, D. C.  
 Sept. 14-16. Applied International Spectroscopy Colloquium. Venice.  
 Sept. 14-16. International Federation for Documentation. Rome.  
 Sept. 15-21. World Medical Association. Stockholm.  
 Sept. 16-19. American Institute of Chemical Engineers (Regional). French Lick, Ind.  
 Sept. 16-19. American Institute of Chemical Engineers (Regional). Sheraton Hotel, Rochester, N. Y.  
 Sept. 16-22. Association of German Physical Societies. Karlsruhe.  
 Sept. 17-20. American Hospital Association (Annual). St. Louis.  
 Sept. 17-21. Conference on Industrial Experimentation. Columbia University, New York.  
 Sept. 17-24. World Tobacco Congress. Amsterdam.  
 Sept. 18. International Symposium on Chemistry of ACTH, sponsored by Armour and Company. Palmer House, Chicago.  
 Sept. 18-22. International Symposium on Nonlinear Vibrations. Ile de Porquerolles, France.  
 Sept. 19. American Medical Writers' Association (Annual). Pere Marquette Hotel, Peoria, Ill.  
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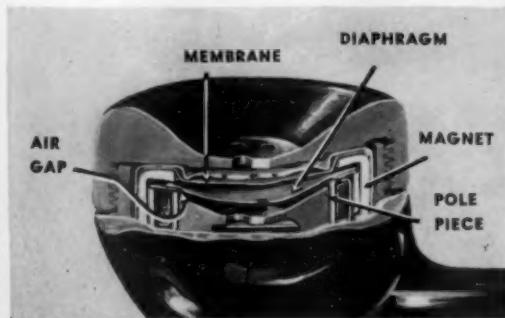
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